CIVIL ENGINEERING

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Bridge Over the River Conway, Wales, Built by Thomas Telford in 1826
Extra Cables Were Added Above the Four Original Chains Twenty-Five Years Ago

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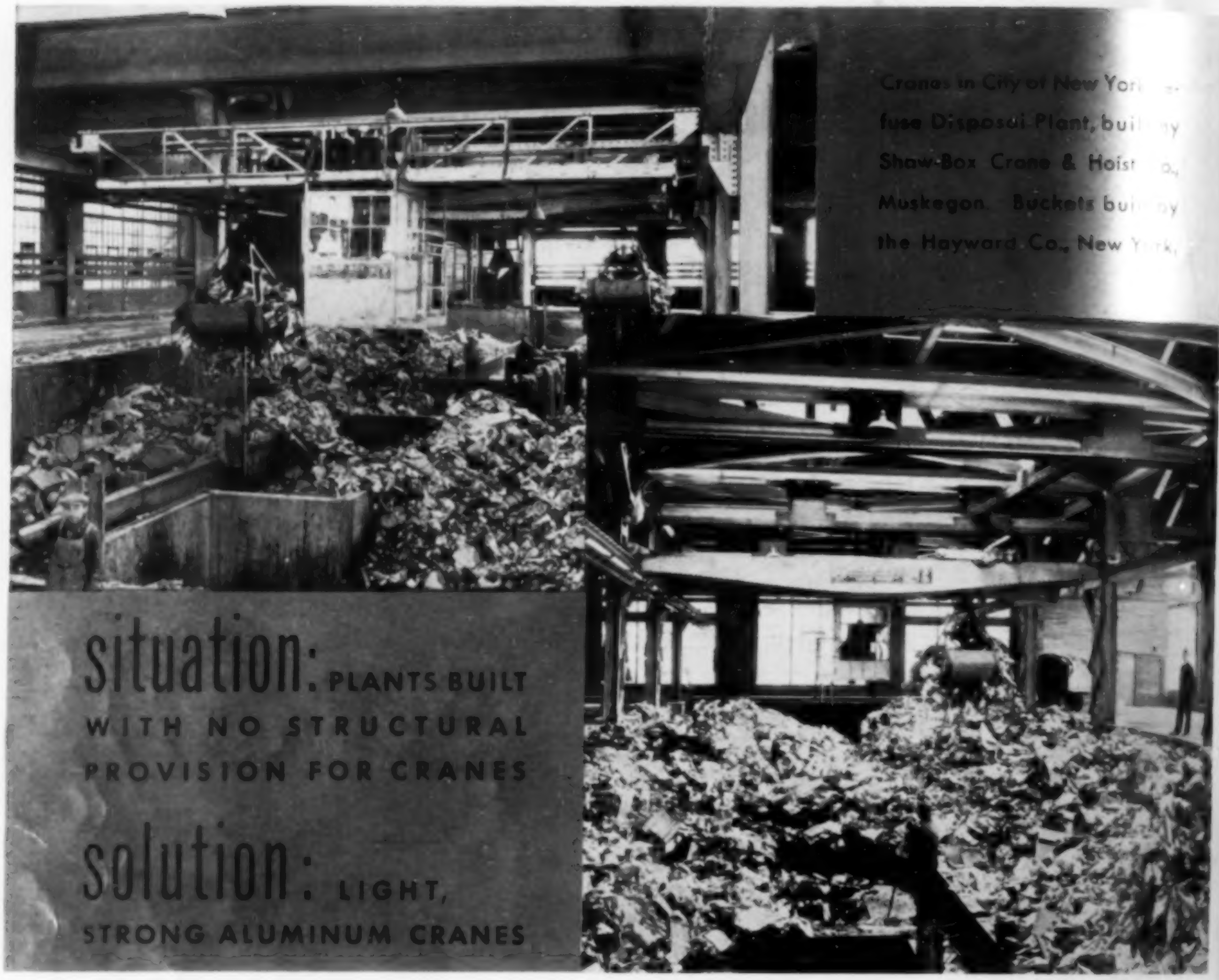
APRIL 1937



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Mission Concepcion

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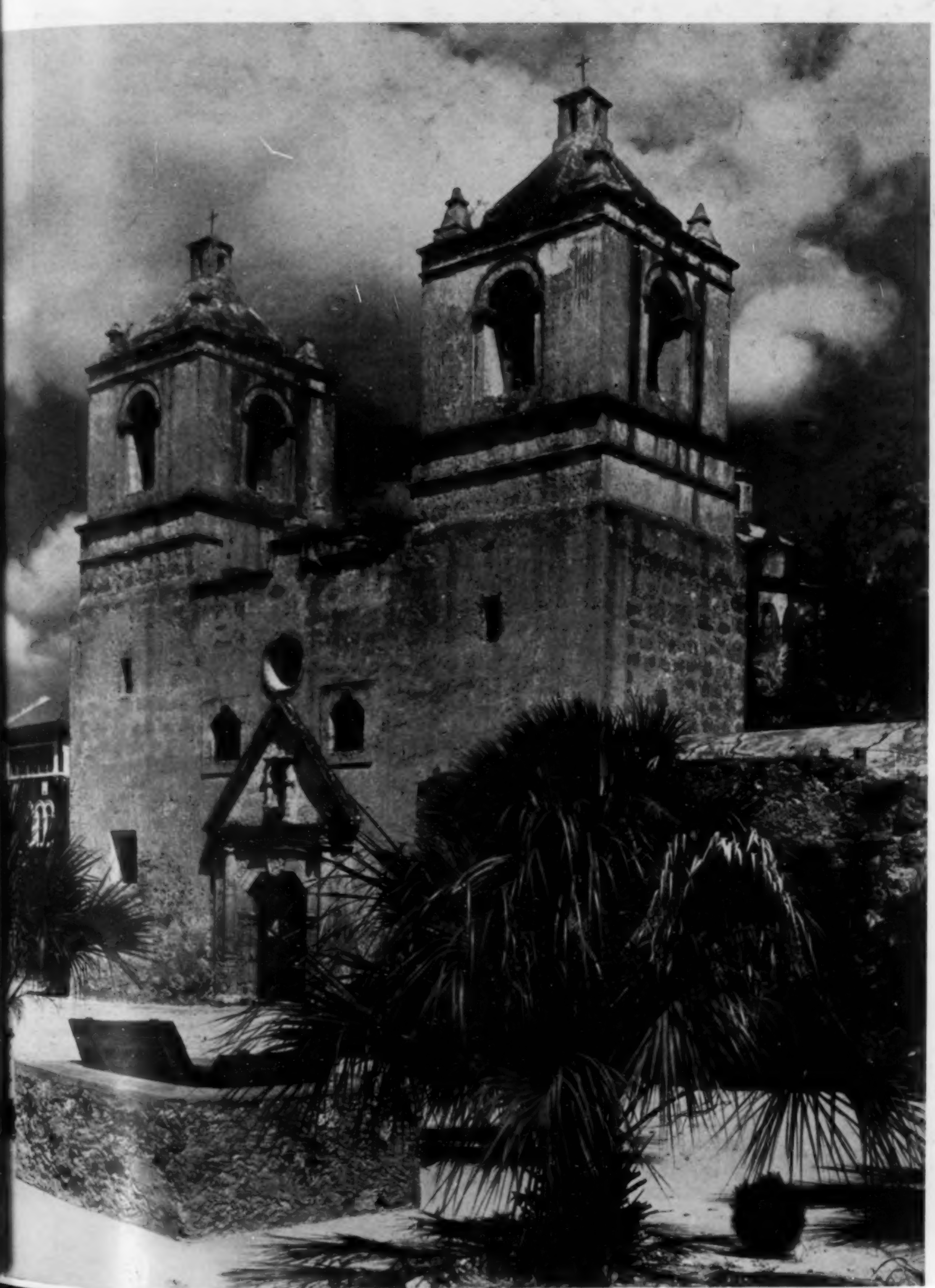

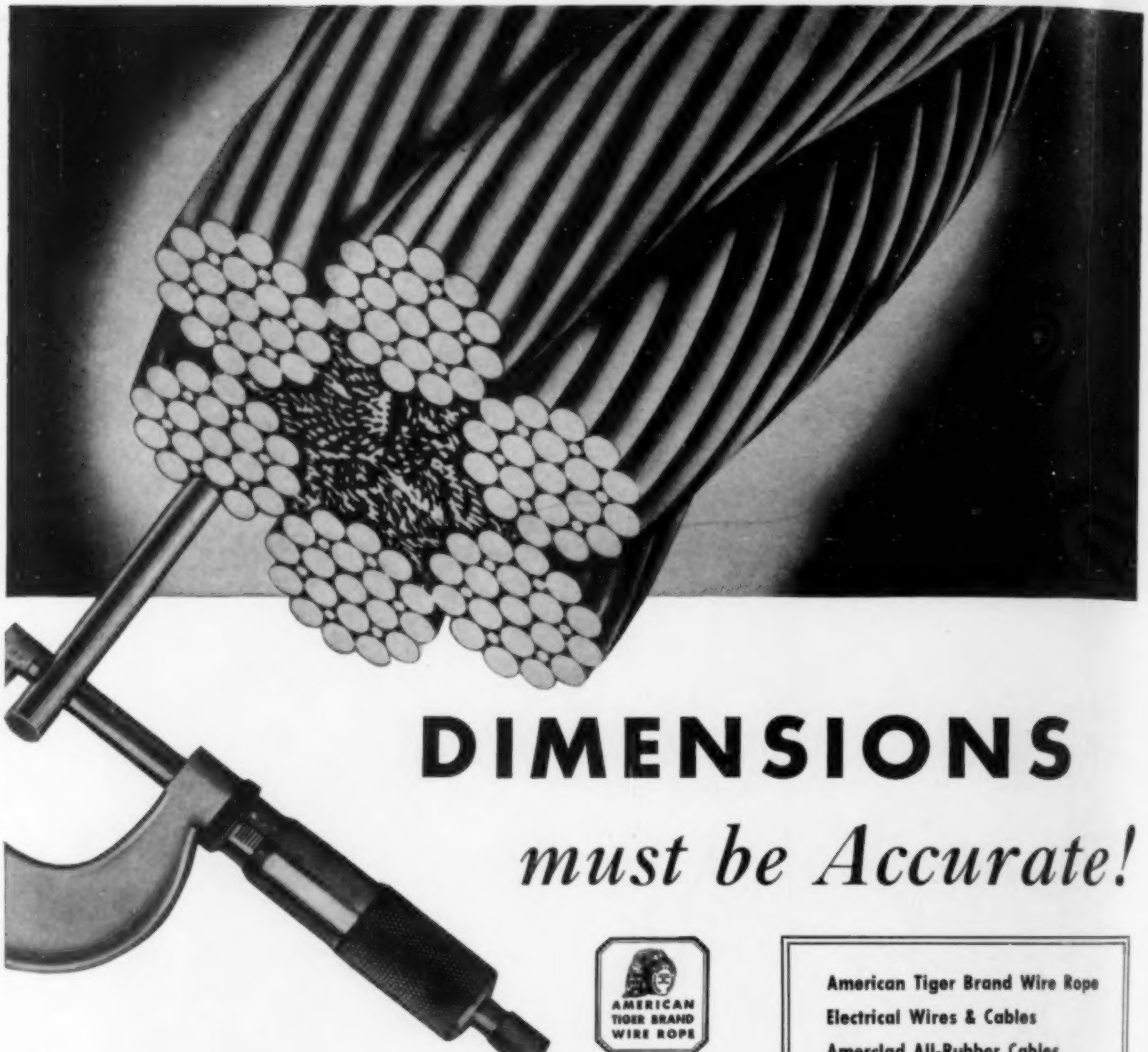

Among Our Writers

N. W. DOUGHERTY holds degrees of bachelor, master, and civil engineer from the University of Tennessee and Cornell University. After teaching at Cornell and George Washington University, he became professor of civil engineering at the University of Tennessee in 1916. Professor Dougherty is at present state representative to the U. S. Coast and Geodetic Survey.

ARTHUR E. MORGAN has had 35 years of experience in water-control engineering work, largely as president and director of his own company. Previous to his appointment as chairman of the board, Tennessee Valley Authority, he served as chief engineer for the Miami Conservancy District and for other large water-control projects. He has written a large number of books and articles on reclamation and other subjects.

CLAIR V. MANN holds a degree of Ph.D. in engineering education. He became assistant professor of engineering drawing at the Missouri School of Mines in 1920 and professor in 1923. He is also chairman of the University's committee on engineering education, and is the author of numerous articles on this subject.

C. G. STIPE holds master's degrees both in arts and science, as well as the professional degree of civil engineer. He has been in teaching work for 15 years, first at the University of South Dakota and since 1927 at the Michigan College of Mining and Technology. His research in geophysical prospecting methods covered four summer seasons.

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Y. TOTAKE was formerly chief engineer of the Tokyo Underground Railway Company. He is now adviser on subway construction to that company and to the Transport Board of the City of Osaka.

WILLIAM BOWIE served for 14 years in the U. S. Corps of Engineers on various classes of surveying and charting in the United States and its territories. From 1919 until his recent retirement he has been chief of the Division of Geodesy of the Coast and Geodetic Survey. He is a member of many scientific societies and has written numerous technical articles.

JOHN F. BAKER was engaged first on studies of the strength of rigid airships and later as an engineer in the British Government's Department of Scientific and Industrial Research. Since 1933 he has been professor of civil engineering at the University of Bristol.

JOHN ARMITAGE was captain of Rugby fives at Cambridge University, 1931–1932. For the last five years he has served as editor of the London Journal, *Squash Rackets and Fives*.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Hall-Marks of the Engineer

By N. W. Dougherty

Member American Society of Civil Engineers

Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn.

We know much about engineers as technical men and as men in everyday affairs. We know, for example, that their training is scientific and that their methods are those of science. But it is sometimes asked whether the engineer has any qualities that make him different from other scientific workers, such as a distinctive character, a peculiar personality, or a definite philosophy. To answer this question we must examine his ideals, his methods, and his attitudes.

To be successful and a good citizen, the engineer must have mental and moral integrity in keeping with his responsibilities. Honesty does not make him different from other men, although we sometimes hear quasi-engineers suggest that the profession, as a whole, is too honest to get along. Never was there a greater departure from sound thinking. Surely all will agree that an engineer cannot be too honest, although all may not agree that stubbornness and lack of cooperation are essential to honesty.

If the engineer has a peculiar personality it is due to his outlook on life and his method of solving life's problems; it is a product of his beliefs and his surroundings. Our problem then resolves itself into a search for his philosophy of life and an inquiry into his method of doing things. Where can we find words that will express his innermost thoughts? Four sources immediately suggest themselves: (1) Writers of books for engineers, (2) advertisements that are designed to attract his attention, (3) fundamental laws and codes of ethics of his profession, and (4) speakers and editors of the profession.

In the Eyes of Authors.~Turning first to writers, let us see what can be learned from an examination of books on engineering. Here college professors and others who are literary minded should express motives and desires as well as present theory and practice. Engineering books as a whole undertake to delineate some theory, some method, or some problem. The text will give the method of action and certainly the attitude of mind of the writer, but if we are seeking the spirit of the book, the first few pages should reveal it. The preface, like a sign on a highway, tells the reader what to seek and often how to seek it.

Writers of second and third editions believe engineering students and other readers are Athenians at heart, according to Luke's definition of Athenians as those who "spend their time in telling and hearing some new thing." Preface after preface gives eloquent evidence of the desire of the author to add something new to engineering knowledge or practice and, usually, of his belief that he has done so. New things are essential, but it would be a pleasure some day to pick up a book and read in the preface: "I am writing this book over because the first edition was not as clear, as concise, and as well done as I have tried to make the new edition."

In the prefaces to first editions we get a better view of what the writer is trying to do and what he believes his reader will want to read; as, for example, "The author has tried to use few words and to have them mean something." Others say they are presenting basic principles, fact and theory, fundamental concepts, or the best practice, with a logical approach and as completely as possible.

Do these and similar phrases give us a conception of the engineer as a type necessarily differing from other technical and professional men? Comparable search among the authors of books on other sciences will reveal a similar story. But in all his writings, the engineer is definitely placed in the class of searchers after truth. Throughout engineering literature, authors stress accuracy, hunt errors, and seek dependability.

Advertisers Reflect His Attributes.~Reading of periodicals reveals that the advertiser of products used in engineering has about the same general conception of engineeers as authors have. He has enlarged it a little to stress practicality and dependability, but he resorts to basic principles, economics, and efficiency to present his wares. At first thought advertisements addressed to engineers would seem uninteresting and monotonous. But in running through them one finds certain word

used which are definitely in the vocabulary of the engineer. Products are described as convenient, uniform, economic, dependable, or as being something new, efficient, and of easy operation. They are said to be of ample capacity and instantly available, with advanced features and flexibility; having long life, mobility, power, and versatility, yielding profit and saving dollars—all qualities that appeal to engineer purchasers.

These and similar phrases lead to the conclusion that the advertiser looks upon the engineer as one who wants efficiency, dependability, and flexibility, and who is saturated with the desire for economy.

Society Codes Are Enlightening.~In seeking the ideal, engineers, like other professional men, have adopted certain codes of ethics. At first thought we would expect to find here their innermost hopes and desires, but on analysis we must see that their philosophy cannot be expressed in simple rules of conduct which have a very limited field of application. A code that read simply, "An engineer will apply the Golden Rule in the relationships between himself, his employer, and his fellows," would be far more inclusive than any yet written. Ethics place public interest first, owner and fellow engineer second, and the engineer himself third. Engineers should not gossip about each other; they should never cheat each other; they should not brag about themselves. But such ideals do not place any professional group in a special category—they do not even clarify border-line conduct, and so we cannot look in the codes for a revelation of the nature of the engineer. They are barren of expressions of the engineer's genius and are desert land as far as his guiding motives are concerned.

Practically every branch of engineering has its own organization, with a constitution and by-laws expressing its objects, functions, and working methods. When men organize for self-improvement, for the advancement of science, for the study of common problems, and for the development of a spirit of cooperation they are collectively expressing controlling motives.

A detailed study of the activities of engineering societies shows the members perfecting the following program: Publications (they must not only seek the truth but broadcast it to other members and to the world); education (both for their members and for the public at large); professional development (comprising legal recognition and professional improvement); and research (seeking new and useful things as well as seeking the truth for the truth's sake). Such activities earmark engineers as searchers for "goodly treasure" that cannot be bought with a price but must be attained by personal sacrifice.

The Profession Itself Speaks.~As might have been expected, the clearest expression of the ideals of the profession comes from its speakers and editors. One description occurs over and over again—"the engineer is a workshop, not a warehouse or a lumber room"; "only strong men knowingly enter where the portion is men's work." All through the literature of the profession runs the idea of work. Somehow this chord sets the profession apart from the one-time popular idea of education—that it would save its possessor much hard work.

"It is a strenuous life, requiring manliness, pluck, and endurance; it is a most virile profession." Of course this conception cannot be preempted by the engineer to the exclusion of all other professions; it does, however, suggest that initiates must be ready for "a stiff fight and a swift race." Those who drop by the wayside and blame the profession are those who never should have entered the race and who have never really qualified.

"The engineer is a maker and user of power." "He must master what he touches; he must adapt old forms to new uses; he must create new methods of reaching old ends." Without the ability to do these things the engineer cannot hope to practice his profession with any chance of success. Never can he say: "Thank God, I will not have to study any more." Graduation from college merely places him at the beginning of a long and studious trail. He who would practice engineering must keep awake or the procession will go by and leave him to his mediocrity.

Granted that many of these ideals were expressed to the younger members of the profession and consequently reflect the hopes and longings of the speakers rather than the hard experiences of exacting practice, yet throughout persist a number of reiterated thoughts: the engineer is a thinker; he is accurate, understanding, thorough, original, systematic, intelligent, practical, and efficient; he is filled with courage, candor, enterprise, strength, devotion, comprehension, fortitude, initiative, information, and the spirit of fairness. He accomplishes things, solves new questions, is the master builder, and the genius of a machine age. Should one man possess all these qualities he would be a prodigy of virtue worth his weight in platinum; yet the profession as a whole must possess these and a hundred more.

Serving the Public.~Lest the engineer become too complacent, it is well for him to consider that in the popular mind he is not always accredited so highly. Outside the profession, he may appear as a technocrat who has turned the world upside down and is unable to set it right again; or he may be the technician who has created a world full of technological unemployment.

But by and large he is given his share of credit. His fairness and honest search for truth are held up as an ideal for all. It is recognized that he has perfected the technique of the master builder, has harnessed power to the wheels of progress through the development of a rational, scientific technique that eliminates, as far as is humanly possible, waste and inefficiency in the utilization of our human as well as material resources. A large and effective group believes that this same technique and method can be effectively applied in solving many of our pressing social and economic problems.

This, however, must come from within the profession—a growth outwards, not a grafting onto the engineering tree of some false fruits of philosophy or economics or sociology. Engineering can cope with its continually increasing responsibility to society, and the problems of its ever-enlarging field of practice by developing its own distinctive qualities and methods and applying them in these newer fields. Engineering problems will not be solved by depending on so-called economists and sociologists, but by developing a broader activity for which the engineer's own virtues so well fit him. Will he recognize this broadened field for professional activity and public service?

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Number 4

Planned Utilization of Water Resources

Growing Sentiment Favors Public Water Control by Watershed Authorities

By Arthur E. Morgan
Member American Society of Civil Engineers
Chairman, Board of Directors, TVA, Knoxville, Tenn.

PUBLIC control of water resources for the public good is a concept that is growing steadily in the United States, together with a realization of the advantages to be gained by coordinating and unifying development for all of the various water usages. But federal and state legislation is first necessary to permit the formation of organizations with the authority to undertake such unified development. Dr. Morgan suggests that this legislation may take the form of constitutional amendment or interpretation, organization of interstate water-control districts, or compacts between the states. The accompanying article, which is abstracted from a paper delivered on September 10, 1936, before the Third World Power Conference at Washington, D.C., concludes with a brief account of the work of the Tennessee Valley Authority, presented as an example of planning for the unified control of a large river system.

MOST water-control projects in the United States have aimed at control for particular usage, such as navigation, flood control, irrigation, recreation, water supply, or power development. Only in recent years have there been any general studies or projects covering large drainage areas and designed to secure the greatest public benefits for all purposes. These have originated from a recently growing recognition that the many uses of water and land are interrelated and that a growing population demands more services and a more complete utilization of the country's natural resources.

Because of the extreme variations in rainfall, temperature, and topographic conditions in the United States, water problems and their solutions vary widely from region to region. Rainfall varies from less than 4 to more than 80 in. a year; average annual temperatures vary from 40 F on the northern border to 75 F in the Southwest; topography ranges from lowland plains to mountainous areas over 10,000 ft in elevation. In some parts of the country agriculture depends entirely on irrigation; in other parts it depends on drainage. Water-power sites are abundant in some areas and almost entirely absent in others.

Before considering the broader problem of an adequate system of planned utilization of water resources, it will be helpful to review the more or less spontaneous growth of water developments in the United States, and the results that have been achieved.

Scenic Drive in a Tennessee Valley Authority Park

Before the development of railroads, streams were used for navigation under difficult and primitive conditions. With the steamboat, the Mississippi River became a busy artery of commerce. Since these early years it has been a public policy to develop navigation in order to facilitate and encourage private industry and trade. The harbors in our lakes and on our sea coasts were developed at public expense for the use of industry. On the other hand, a large number of so-called "pork-barrel" appropriations were made by Congress to improve domestic navigation on inconsequential rivers and creeks. These were in many cases a waste of public money, and on the whole they did not indicate any mastery of navigation principles nor did they represent any thoroughgoing undertaking to make navigation actually possible and profitable.

Various canals were built in the eastern United States but these fell into comparative disuse with the coming of the railroads. More recently, improvements in the connecting rivers have made the Great Lakes the greatest system of inland waterways in the world. When the navigation program now under way is completed, the Mississippi, Ohio, Illinois, and Tennessee rivers will provide a combined system comprising about 5,000 miles of inland navigation with a minimum draft of 9 ft, and the Missouri and other rivers will add hundreds of miles more with a minimum draft of 6 ft.

At present the greatest handicap to navigation in the main channel

NAVIGATION ON THE TENNESSEE RIVER
The Present Program Will Provide a 9-Ft Channel

of the Mississippi River is the extreme fluctuation of water level, amounting to 50 ft or more. Where regulation by dams and locks is practicable, it will greatly reduce this fluctuation and will make navigation very much more feasible and more profitable.

Under the Constitution, the promotion of interstate commerce by navigation improvement was a recognized power of the national government, whereas flood control was an uncertain federal function. It became customary, therefore, for the national government to concern itself with levee, revetment, and other bank protection along the Mississippi River on the grounds that navigation would be benefited, though the chief benefit from such works was in the flood control provided. Since 1927, when a great flood on the Mississippi River broke down the levee system, the entire problem of flood protection has been reviewed, much more complete data have been assembled, and new principles of control are now being studied.

River-control practice in America, especially on the Mississippi, has suffered from two types of extremists. One class of engineers has maintained that control of the Mississippi must be achieved by levees supplemented by channel dredging, and in no other way. The opposing group proposes a large number of small reservoirs on the headwaters as an adequate means for control on the lower river. Thorough analysis of the subject shows that such a system of small reservoirs would be enormously expensive and, to a large degree, ineffective in controlling high-water stages on the lower river, although of substantial assistance in improving low-water stages. However, if a vast number of such reservoirs should be constructed for other purposes, they might have a substantially beneficial influence in reducing high-water stages.

The conflict between these two uncritical dogmas has been a great handicap in the development of effective and economical flood control. Reservoirs of large capacity, located at least in part as near as possible to the mouths of the main tributaries, may retard the flow of the Mississippi during high water, and thus play a very important part in flood control and navigation. A comprehensive system of small reservoirs will be chiefly justified by their local benefits. The time is approaching when an assembling and a thorough analysis of facts may determine policies in this and other phases of the planned utilization of water resources.

In the United States there are some cases where comprehensive planning has been employed in developing adequate flood-control undertakings. One of these is the Miami Conservancy District in Ohio. The Conservancy Act under which the district operates reflects the consensus of the best authorities in this country and Europe on flood-control problems. In general, the type of organization chosen was the form commonly known as the public corporation, with much of the freedom of a private corporation, but with necessary governmental powers and with provision for complete publicity and periodic appraisal by outside authority. After twenty years of experience, this general form of organization is recognized as one of the most effective instruments which has yet been devised for the purpose.

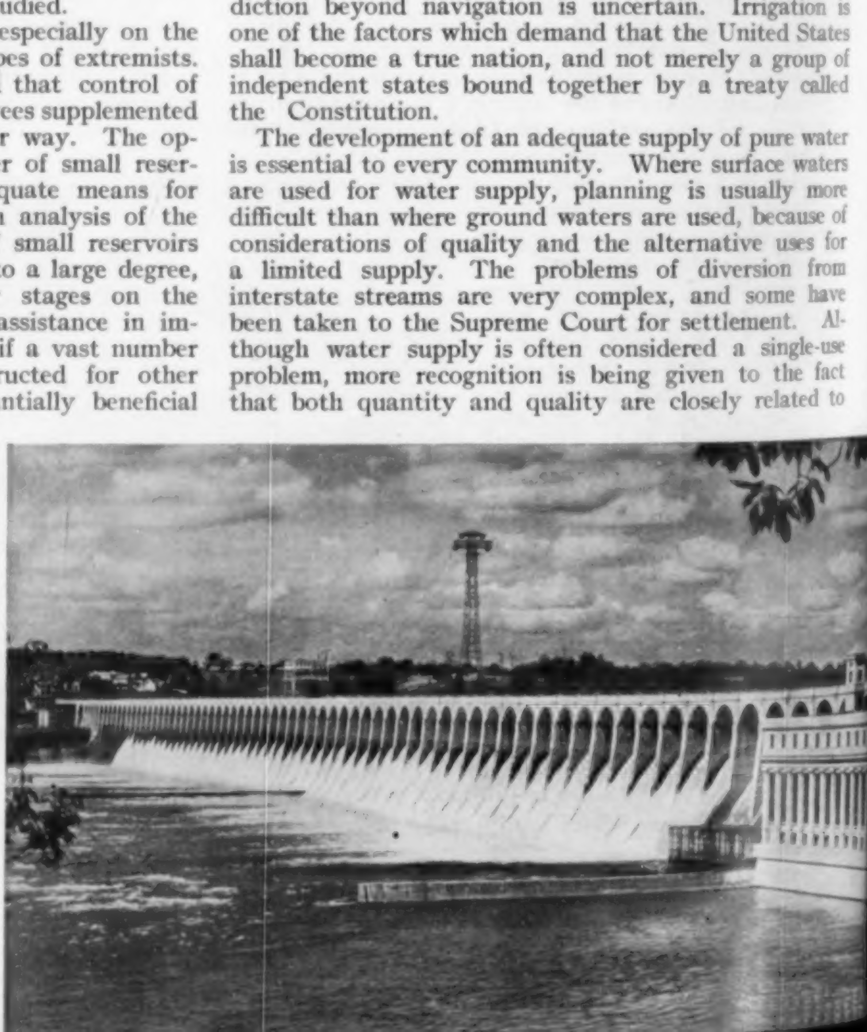
IRRIGATION AND INDUSTRIAL USES OF WATER

In arid regions, such as those forming much of the western half of the United States, agriculture and community life depend on large-scale irrigation. The irrigation works necessary for efficient use of water resources are so costly, and the promotional risks so great, that private enterprise has limited itself to the simpler low-cost developments.

Hydroelectric power frequently is coupled with these irrigation projects. In fact, joint power and irrigation development is an essential element of several of the most expensive new projects, the power revenue being depended upon to cover a large part of the irrigation cost, while at the same time the irrigation project furnishes the basic market for the power output.

Conflicts between states over claims to the waters of interstate streams are frequent and long drawn out, owing to the fact that the federal government's jurisdiction beyond navigation is uncertain. Irrigation is one of the factors which demand that the United States shall become a true nation, and not merely a group of independent states bound together by a treaty called the Constitution.

The development of an adequate supply of pure water is essential to every community. Where surface waters are used for water supply, planning is usually more difficult than where ground waters are used, because of considerations of quality and the alternative uses for a limited supply. The problems of diversion from interstate streams are very complex, and some have been taken to the Supreme Court for settlement. Although water supply is often considered a single-use problem, more recognition is being given to the fact that both quantity and quality are closely related to



WILSON DAM, SHOWING SPILLWAY AND POWER HOUSE

flood control, forest cover, soil erosion, and regulation of river flow.

As the country has become more thickly settled and water consumption for both domestic and industrial uses has increased, it has come to be recognized that many problems of water supply are no longer local and isolated but are of state, regional, and national importance. Increased and varied demands on limited supplies necessitate some degree of planned control.

POWER AND OTHER USES OF WATER

Like many other water-control activities, the development of power sites has generally been considered a single-purpose undertaking. In relatively few cases have there been any attempts to combine the various uses of water into a unified whole for the development of an entire river system. This is not surprising in view of the difficulties faced by promoting enterprises. For while some uses of water, as for electric power, can be readily measured and sold, other equally important uses are less tangible and therefore cannot easily be measured and distributed. These may include stream-flow regulation, flood control, navigation, or water supply.

Probably the first water-power installations in the United States were the small mills for grinding grain or sawing timber which were established in most communities where sites were available. With the spread of the industrial revolution to the United States, the larger water-power sites were rapidly developed. Because of relative freedom of location, the early steam plants eclipsed water power until the beginning of the electric era and the development of electrical transmission. Thereafter for about three decades wherever water power was available steam lost its preeminence as an economical source of power. Hydroelectric development had been carried close to the theoretical limits of its development, while steam power was still of low efficiency.

However, with the rapid improvement in steam-power generation witnessed during the past twenty years, the relation has changed again, and the economy and flexibility of steam power is putting hydroelectric power on the defensive. The recent development of small-unit Diesel engines of high efficiency, with their low capital cost, flexibility, and freedom from long transmission lines, may even bring to a dramatic end the short era of far-flung power systems.

Yet the day of water power is by no means over. In the past the feasibility of power projects has generally been determined on the basis of a single use, rather than by viewing the power possibilities as but one of several uses. When sites are developed systematically for a variety of purposes, the total cost of the project can be allocated among the various uses, since benefits are received from each function. A comprehensive coordinated project therefore yields many benefits at lower costs than would be the case if each use were developed individually.

OTHER ASPECTS OF WATER RESOURCES

Most cities in the United States are built along rivers or other bodies of water. Although in general the margins of these streams are potentially the most beautiful elements of civic environment, in many cases they have been used for railroad yards and garbage dumps. The developments along the Charles River at Boston, the upper Schuylkill at Philadelphia, the Potomac at Washington, D.C., and the small streams along Westchester County Parkway above New York City are

INTERIOR OF COMPLETED SCROLL CASE, NORRIS DAM POWER HOUSE

examples of fine treatment of stream margins. In the Tennessee Valley, on projects so far undertaken, there are more than 2,000 miles of reservoir margins and river banks, including some of the finest scenery in the South. The natural beauty of these bodies of water will be preserved through public ownership. There is a growing appreciation of the esthetic value of river margins, and in hundreds of cases the beauty of stream banks as well as lake shores and ocean beaches is being recognized as a priceless natural resource.

Industrial waste makes many American streams unfit for human use and destroys all aquatic life. Thus, one of the principal problems is the prevention of stream pollution. The value of our water resources for fisheries and wild-fowl reserves is gradually becoming evident, and it is probable that in the future these less direct economic uses will rise in public estimation.

INTEGRATED WATER CONTROL

Water control in the United States began with the rough and ready endeavors of the early population to meet its most pressing needs, and developed with little consideration for the larger problem of interrelated uses of water for optimum benefits. We must now take the actual situation and endeavor to prevent further nullification and complication of effort. If our water resources are to be utilized in a planned and integrated manner, we must discover their full possibilities, appraise their relative importance and value, provide long-range unified plans for their areas, and exercise guidance and control in their development. Only in this way can the various uses be realized as fully as possible, supplementing rather than conflicting with one another.

Water is peculiarly a public resource. It is a vital necessity; its use generally affects many people in

addition to those who immediately control it; it has varied uses; it pays no attention to property lines; and it changes its location. All these factors indicate the need for public ownership and administration, which should be non-partisan, non-political, businesslike, and technically efficient.

COMPLETED HIGHWAY OVER THE NORRIS DAM, OCTOBER 1936
Clearing Line in Background Shows Ultimate Reservoir Elevation

Since no provision has been made in the national government for the unified development of water resources, it would seem desirable to make some agency responsible for the integration of federal, regional, and state activities related to conservation and utilization. There is at present no such integration. The federal government now touches particular parts of the problem through the more or less independent activities of various agencies. A few states have coordinated their departments concerned with water activities, but others have done very little. The lack of integration between the various agencies of government results in conflicting plans.

Coordinated economy in water-control projects is desirable, but sometimes in order to make possible the expression of new ideas and to give reasonably free range to engineering competence of a high order, direct competition or duplication of lines of work in the government service may be justified. Constructive effort is as apt to be personal as to be institutional, and that organization is best which results in the greatest creative effort. Yet, unless some substantial advantage is served by multiplicity of effort, coordination and unification are desirable. It is not, therefore, practicable to have any absolute rule or practice about administrative unification.

One of the first essentials for economical planning and execution of multi-purpose water-control projects is the assembling of underlying data and the making of basic surveys. A beginning has been made toward collecting these basic data, but for many sections of the country the material is very meager and planning is consequently very difficult.

Comprehensive legislation, both federal and state, is needed for the integrated development and utilization of our water resources. Many water-control problems are within the confines of a single state and can be worked out without interstate complications. But many truly national or regional problems cannot be met in a constitutional way because the national government is barred from undertaking them under a strict interpretation of the Constitution.

In all lands, most water-control laws reflect specific needs. In the United States there are a great many laws providing for the peculiarities of specific cases but relatively few with general and inclusive provisions. The result tends toward a hodgepodge of conflicting and inadequate legislative provisions.

Water-control legislation should deal with priorities of water use, with administrative procedures for initiating and executing water-control projects, and with allocation of costs. More limited legislation for special forms of water use and control would still be necessary but should play a smaller part in the program.

While the powers of the federal government to regulate water and other natural resources are limited, the powers of each state are virtually restricted by its boundary lines. But nature is not concerned with man-made boundaries, and nearly all major water problems involve contiguous states. The solutions cannot be satisfactory if each state is to treat its part of the problem as isolated from all others. This division of power has made it very difficult to formulate constitutional plans for the control of the many complex water problems in need of solution.

A CASE IN UNIFIED PLANNING

It may now be profitable to consider the work of the Tennessee Valley Authority as an example of planning for the unified control of a great river system. Today the Tennessee River experiences violent floods and periods of very low water, but potentially it is a great waterway for navigation. By building dams on its tributaries, assistance can also be given to flood-control plans for the Ohio and Mississippi Rivers. Moreover, the same works which provide for navigation and flood control can be used to generate electricity.

Culminating a hundred-year program of improvement by many small increments, each of which left inadequate water-control conditions, Congress created the Tennessee Valley Authority in 1933 and authorized it to construct dams on the Tennessee River and its tributaries to provide a 9-ft navigation channel from Knoxville to its mouth, to control flood waters in the Tennessee and Mississippi River drainage basins, to generate water power at these dams, and to market it, specifying that stream flow be regulated primarily for purposes of promoting navigation and controlling floods. The Tennessee Valley Authority now has under construction six dams, of which two are completed, and has formulated plans for the complete development of the river by the construction of four more dams, and by improvements to existing structures.

Most of the dams on the main river will provide relatively little seasonal storage. By building dams on the tributaries, where storage is available, the river can be so regulated that much of the heavy winter flow can be stored and released during the dry weather of late summer and fall when it is most needed. This supplementing of main-river dams with large tributary dams will provide the most effective and economical control of the river that is possible for navigation, flood control, and power development. Norris Dam, on the headwaters of the Tennessee, will approximately double the prime power at every dam down the river.

In addition to the construction and integrated operation of reservoirs, the control of soil erosion on the watershed is essential to the unified development of a river system. Unless erosion is checked, reservoirs and river channels gradually fill with silt, providing less

storage capacity for adequate flood-control and navigation requirements. This is particularly the case in the Tennessee Valley. Soil erosion can be adequately checked by a protective covering of vegetation, and the Tennessee Valley Authority is cooperating with the land-grant colleges and the Department of Agriculture to bring about a change in agricultural methods in this region. A part of TVA's program is the development of cheap phosphate fertilizer at the old war-time nitrate plant at Muscle Shoals.

Studies are being conducted by TVA to determine which lands should be reforested, and the Authority is advising with the U. S. Forest Service and state departments of forestry on proper methods of reforestation. Narrow strips of land have been acquired around the reservoirs, the control of which is of critical importance in reservoir protection. Improved methods of soil management used on these reservoir margins probably will have little effect on the intensity of great floods, but they are highly beneficial in other respects. In these ways, not only will soil erosion be controlled, but the region's productivity will be increased, its welfare enhanced, and its living standards raised.

Before Work Started Gullies Destroyed 80 Per Cent of This Slope

The Same Area After the Work Had Been Completed by CCC

CHECKING SOIL EROSION, CLAIBORNE COUNTY, TENNESSEE

IMPORTANCE OF ENGINEERING DATA

Both in the construction and in the operation of works for the unified development of the Tennessee River system, accurate and adequate engineering data are of primary importance. In the construction of dams by private interests in the Tennessee Valley area, great embarrassment has occurred in certain instances because of inadequate information. An engineering organization that would be difficult to assemble for a single structure, and a well-organized program of surveys and plans, are feasible and economical when their cost is distributed over the various works incident to the unified development of a large river system.

Maps necessary for engineering planning are being secured by the Authority in cooperation with the U. S. Geological Survey. Hydrological and meteorological data essential in the planning of hydraulic structures are being collected in cooperation with other federal and state agencies and private companies.

Geological studies are made to determine the most feasible dam sites, as well as to determine whether valuable mineral deposits might be submerged in proposed reservoirs. Studies are also made of the major mineral deposits in the area, as their location and development may affect the use of navigation channels and electric power, as well as the planning of highways.

In the planning of specific structures, the value of unified development is also apparent. Haphazard development of even the finest dam sites may prevent the best development of a unified system, since an individual can preempt a choice site for a relatively small dam that thereafter may stand in the way of economical and effective general development. The Authority is continuing its study of a unified program beyond the limits of the specific works already recommended to Congress, so that conflict and waste in public and private works may be prevented.

In the actual construction of dams, the value of a unified program and an orderly sequence of development is again evident. By a well-planned schedule of operation, the most economical usage of men, equipment, and materials is possible. The Authority has already profited to a considerable extent in this respect. It is also making certain social and economic studies. These include surveys of the number of farm owners and the condition of tenant farmers who will be displaced by the reservoirs, investigations to determine where they can best relocate, and studies of land planning and use and of forests and forestry conditions in and about the reservoirs. Certain school districts are disrupted, and their reorganization must be worked out. In some instances bonds have been issued for schools or roads that will be submerged, and settlements must be made with the counties involved. Population studies are being made for such uses as relocating highways, railroads, and schools.

As the United States has developed from a nation of pioneers to a highly organized and industrial people, the use of water has gradually changed from unregulated exploitation by the first claimant to the beginnings of orderly planning and systematic control. In the course of this development, the concept of water as a public resource that must be publicly controlled and used for the public good has steadily grown. Few elements of water control in the United States remain in the hands of private industries. Our harbors are managed by the federal government; our navigable rivers and lakes are similarly controlled. Practically all large drainage enterprises are publicly constructed and administered. Most public water supplies are publicly owned, though there are still a number of private utilities supplying water to municipalities.

The one conspicuous exception to public ownership and management of water resources is in the field of hydroelectric power. Even here, by the Federal Water Power Act of 1920, the federal government formally claimed ultimate control of all waters in which it had a constitutional basis for so doing, and made provisions for licensing private hydroelectric power companies for limited periods. Moreover, during recent years the federal government has actively engaged in multipurpose development of water resources, including the large-scale development of hydroelectric power.

The Nature of Engineering

Including Thoughts on Its Origin and Its Relationship to Other Knowledge

By Clair V. Mann

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WHAT is engineering? What should be said as to its origin and content? Light is thrown on the nature of engineering by Professor Mann through consideration of the forces and properties of materials with which it deals. In discussing the beginnings of engineering, some interesting speculations are introduced as to the probable activities of the earliest engineers, as well as data on the reasoning faculty in higher animals. Professor Mann also endeavors to define engineering in its relationship to other branches of knowledge, and concludes with a subdivision of the profession both functionally and with respect to its various fields. The following article is abstracted from one of the author's lectures at the Missouri School of Mines. The illustrations were furnished through the courtesy of James K. Finch, M. Am. Soc. C.E.

MANY persons have attempted to frame short definitions of engineering, but the field is so broad and varied that as yet no universally accepted definition has been formulated. The classic definition, commonly understood to have been written by Tredgold, states that "engineering is the art of directing the great sources of power in nature for the use and convenience of man."

Engineering, like medicine, is probably so comprehensive and diverse that no human being, however gifted, will ever be able to practice it in all its forms. Nevertheless, a single individual may pass through a considerable range of engineering activity in some one major field, beginning with the manual tasks, passing through the technical, and ending with the executive. In fact this is the usual process for engineers who attain any eminence, since nearly 75 per cent of mature engineers reach executive positions after years of service in technical fields.

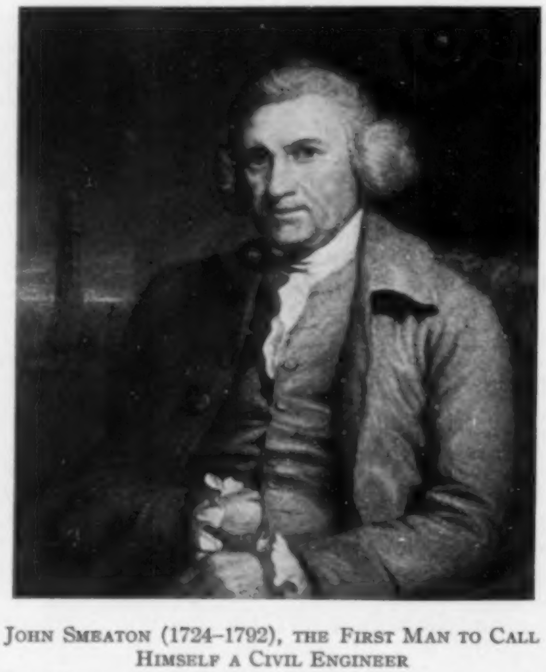
In the day of the Adam of Genesis, or the ape-man of evolution, the ability to pick up a log and lay it in an appropriate place across a stream to form a bridge would no doubt have constituted engineering ability of a high order. A man's engineering aptitude could then have been measured by the size, weight, length, or suitability of the log he might manage to use. According to such a concept, the primitive engineering aptitude of the ape-man would today be in a class with the aptitude for common labor on construction work. Modern engineering, utilizing all the advantages of mutual cooperation, lays a bridge of steel across streams whose width is many hundreds of times the length of the primitive log.

THE PROBABLE BEGINNINGS OF ENGINEERING

Let us examine the subject-matter of engineering in some detail. According to our definition, in engineering we harness the forces of nature and make them work for us and serve us to provide conveniences and comfort and protection. What are some of these forces of nature? What are the materials with which we deal? And how do we control and utilize them? The list in Table I is suggestive.

Such questions as these move my liveliest imagination as I strive to comprehend what must have been the beginnings of engineering and science among primitive races. How did they come to know, one by one, these forces and facts of nature? Which forces did they know first? And how did they in time come to discover the materials of nature, and learn how to utilize them? Man must have been from the beginning subject to the terrors and ravages of storms, floods, and wild animals. He must early have known of the force that sways the tree tops and causes them to moan and even to break. He surely must have been acquainted with the phenomena of light, heat, and cold, and with many forms of motion in nature, including the movement of sun, moon, and stars. Lightning played frequently overhead, and it is not at all unlikely that man first saw fire when it was kindled by lightning or by molten lava. The power of fire to crack rocks, especially when water is applied, was a part of early scientific knowledge. The discovery that fire could be quenched by water might easily have come from watching the effects of rain and snow falling upon it in nature. The melting of metals by fire probably came accidentally, when some individual kindled a fire against a mineral ledge or bluff and presently beheld a bright stream of molten metal running forth from beneath his fire, to cool in his footprints in the soft earth and stimulate in him the idea of pouring molten metal into moulds.

The power of rushing wind and of swiftly moving water, either in the form of river floods or as ocean waves or tides, must have been known in early times. The falling of rocks from cliffs and cocoanuts from trees—and of human beings themselves—must have added to early engineering knowledge, although the underlying principles were understood only in modern times, when Newton saw the apple fall and began to formulate the laws of gravitation.



John Smeaton (1724–1792), the First Man to Call Himself a Civil Engineer

His Edystone Lighthouse Appears in the Background. By Woodman After a Portrait in the Possession of the Royal Society

The energy of the bent sapling and tree branch was used by early man in fashioning his bow and arrow and in preparing snares for the capture of animals for food. As for the phenomena of velocity, inertia, impact, hardness and softness of substances, tenacity, and brittleness—our primitive scientist surely dealt with these in making his implements of flint, wood, and bronze. Whether or not he understood them well enough to make suitable definitions, he used them. Likewise he utilized the properties of flexibility and tensile strength provided by thongs of skin, plant fibers, and hair, used for purposes of weaving and tying. He probably had an early acquaintance with many phenomena of electricity other than lightning. Whether he could satisfactorily explain them or not, early man made use of all the phenomena and materials that he could, and thereby became the primitive applied scientist, the primitive engineer. He made use of caves and huts as shelters from the elements and from animals, and employed skins and clothing as non-conductors of heat and cold, even though he had never seen a book on physics, and did not know there was such a thing as thermodynamics or textile engineering.

SEBASTIEN VAUBAN (1644–1706), GREAT FRENCH FORTRESS BUILDER

Voltaire Called Him "First of Engineers and Best of Citizens"

KOHLER'S EXPERIMENTS WITH CHIMPANZEES

Discoveries have come both through trial and error and through accident. The observing man who builds a structure once and sees it fail will not a second time build it the same way. The alert mind, seeing in physical phenomena cause as well as effect, has carried the human race forward. The classic experiment carried on by Wolfgang Kohler with a group of chimpanzees is worth recounting here, as it suggests ways in which primitive man may have gradually awakened to a scientific study of the phenomena about him. Kohler's experiments were conducted during the years 1913–1917, on the small island of Tenerife, in the Canary Islands, where a colony of chimpanzees was established. The isolated and tropical nature of the country made it possible to conduct the experiments under conditions which were closely similar to those of the animal's native habitat.

THE PONT NEUF, OLDEST BRIDGE IN PARIS, BUILT IN 1607

From the Etching by Louis Orr

In one experiment a chimpanzee was not fed in the morning as usual, but instead his food was fastened to the roof of his cage and a box thrown casually upon the floor of the cage some distance from the point where the fruit hung suspended. The ape had never used a box as an implement, and hence ignored it completely, although he could easily have reached the fruit by pulling the box over and climbing up on it. The animal spent many hours in unsuccessful effort, trying to reach the fruit by jumping up toward it, climbing up the walls, and the like. Finally the experimenter dragged the box over beneath the suspended fruit, stepped up on it, reached up and touched the banana. He then got down and threw the box some distance away. Almost immediately the chimpanzee pulled the box over under the fruit, climbed up on it, and pulled down the food.

In another experiment Kohler attempted to see whether Sultan, apparently his most intelligent chimpanzee, could combine two sticks into one useful implement. The sticks were two hollow bamboo rods, one enough smaller than the other so that it could be fitted easily into the end of the larger to form a single long stick. All the animals had frequently used single sticks

TABLE I. SOME NATURAL FORCES AND PROPERTIES OF MATERIALS WITH WHICH ENGINEERING HAS TO DO

Wind	Rain	Mass and weight
Tide	Storms	Velocity
Waves (as of the ocean)	Gravity	Speed
Gravitation	Light	Impulse
Heat	Sound	Inertia
Fire	Electricity	Impact
Melting	Cosmic rays	Force

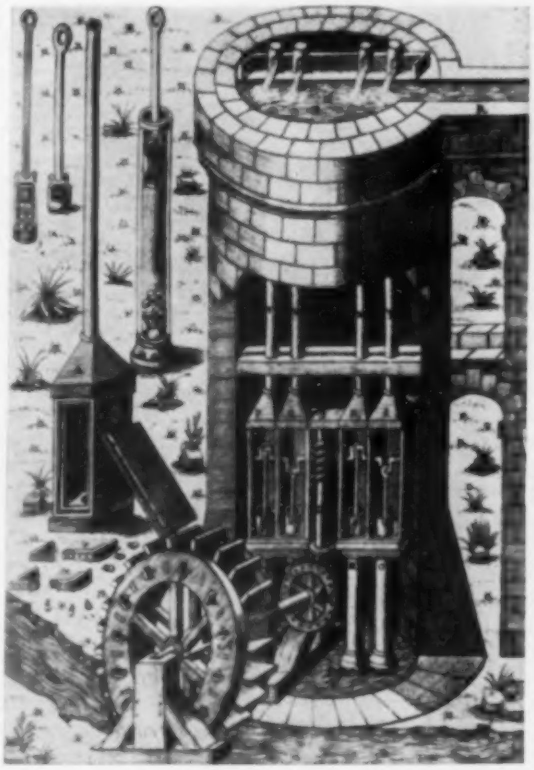
to pull in bananas and other fruit placed outside the bars of their cages. But none had been given the task of joining two sticks into a single one and using the resulting long stick. The set-up of the experiment was as follows.

The chimpanzee was put into a cage along with the two sticks, and several pieces of fruit were placed outside the bars too far away to be reached by either stick alone, but within easy reach of the joined sticks. Judged in the light of this rather simple situation, the animal's behavior seems incredibly stupid to human eyes. First he tried to reach the fruit with one stick and then with the other. This failing, he next pushed one stick out as far as possible, and then with the second stick pushed the first one on until it finally touched the fruit. This actual contact, Kohler notes, seemed to give the animal great satisfaction, but it did not give him the fruit! At last, as Sultan seemed no closer to a solution than at the start, the experimenter give him a hint by sticking one finger into the opening of the larger stick directly before his eyes. But this cue failed to help any, and after an hour or so of futile effort, the ape apparently lost

interest and gave up the task as hopeless. He continued to play with the two sticks, however, and after some manipulation, holding one stick in the left hand and the other in the right, he accidentally got them together. The first connections were loose, so that the sticks frequently fell apart, but the animal persisted in fitting them together, and by means of the combined sticks pulled in with great eagerness not only all the fruit, but all other small movable objects, such as stones and sticks, within reaching distance. On the following day, after some desultory pushing of the one stick by the other (repetition of the old useless behavior), Sultan quickly joined the two and got the fruit.

LEARNING THROUGH EXPERIENCE

Smeaton, the great English bridge engineer, learned how not to build a large bridge by having one of his own design fail because it was built on an unconfined gravel foundation. Canada and America learned how to build great cantilever bridges—and also how not to build them—by studying the manner in which the great Quebec Bridge failed. Great cathedral builders of England spent large sums of money, and much time and labor, in building the tower of one of England's famous cathedrals only to have it fall. A second time they tried and it fell. The third time they sought firmer foundations and this time prevailed.



A TOWER PUMP FROM RAMELLI'S "THEATER OF MACHINERY" PRINTED IN PARIS IN 1588

The ingenuity of individuals bent upon defending their cities under conditions of siege, or upon capturing cities by process of siege, gradually brought to the human race all manner of military machines and devices, many of which have come to have uses in times of peace. Vitruvius, an engineer-architect living about the time of Christ, tells of towers built by the aggressors in siege operations that were used for scaling walls and for launching fire torches and other weapons from outside the walls. He tells also of the defense of a city against such operations by tunneling beneath the walls and pouring into the tunnel all available water supply and slops in order to soften the ground and cause the enemy's tower to tip over. Such "ingenuity" gave to our profession its distinctive name of "engineer."

TABLE II. AN OUTLINE OF KNOWLEDGE

I. Mathematics
II. Physics (mechanics)
III. Chemistry
IV. Astronomy
V. Geology
VI. Biology
  A. Botany
  B. Zoology
    1. Man
      (a) Physiology, hygiene, medicine
      (b) Philosophy
        (1) Religion
        (2) Ethics
        (3) Esthetics
      (c) Geography (human)
      (d) Anthropology
      (e) Psychology
      (f) Sociology, civics, economics, history
      (g) Industries
        Engineering
      (h) Art (applied esthetics)
        (1) Music
        (2) Architecture
        (3) Sculpture
        (4) Painting
        (5) Dance and drama
        (6) Personal decoration
        (7) Language
        (8) Literature
          (a) Drama
          (b) Lyric, essay
          (c) Epic, novel, etc.
          (d) Expression of fact, thought, etc.

In its larger sense, engineering is a process of trial and error, in which the successful trials are carefully recorded and become the basis for other successful design and building. Errors are recorded with equal care, and are meticulously avoided in subsequent construction.

RELATION OF ENGINEERING TO THE FIELD OF HUMAN KNOWLEDGE

In considering the knowledge that forms the basis of engineering, it may be helpful to have an outline of the whole field of knowledge. That prepared by E. L. Johnson, professor of English at the Missouri School of Mines, is given here, in Table II.

The well-prepared engineer must have a working acquaintance with each of the major fields tabulated by Professor Johnson. As the basis for engineering study, we have first the science of astronomy, through which we become oriented to our physical, material universe. From it we derive such indispensable concepts and measurements as those of time, latitude, longitude, planetary motion, and direction (north, south, east, and west). Geology shows us the origin and structure of the earth, and the changes that take place in it from time to time. It is the basis of our knowledge of the extent, position, and availability of salts, rocks, metals, minerals, and quarried products, which are the materials of engineering.

Botany and chemistry also play their part in the process of identifying and producing engineering materials, and these same sciences together with physics enable us to understand the various properties of these

THE MOORISH ALCANTARA BRIDGE AT TOLEDO, BUILT IN 997
From an Etching by Frank Brangwyn

materials, such as hardness, weight, viscosity, ductility, malleability, and tensile strength. Chemistry, physics, and biology acquaint us with the various forces of nature and help us to understand the laws under which they operate. Mathematics gives us the means of understanding the relationships of space, position, volume, and length, and answers the questions "how much" and "how many."

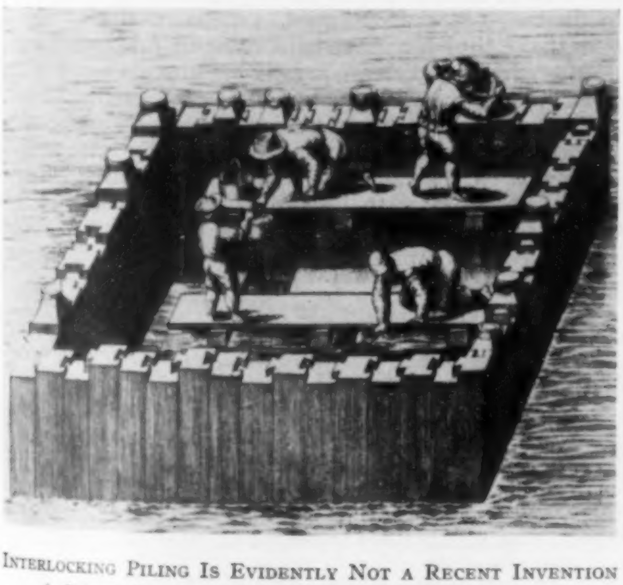
St. Aubin's Engraving of Jean Rodolph Perronet (1708–1794), French Civil Engineer and Greatest Builder of Stone Bridges

Biology enables us to understand plant and animal life, including man himself. This is the basic science for agricultural engineering. Psychology, sociology, economics, and religion enable us to understand and work with the human being himself. Language and drawing are mediums for the exchange of thought and for recording ideas both useful and otherwise. Art woven into engineering design becomes a source of pleasure to those who behold the works of the engineer and the architect. All these fields of knowledge are well-nigh indispensable to the great profession of engineering, and are the bases not only for a well-rounded career in engineering, but also for the whole development of a matured, normal personality.

Most of what are nowadays called the technical subjects are merely specialized extensions of a general field such as physics or chemistry. To this is added the tincture of experimental work or the results of past experience in design, construction, or method, which we call precedent, and which largely characterizes the profession of architecture.

SUBCLASSIFICATION OF ENGINEERING

Engineering may be divided into various professional classifications—agricultural, ceramic, chemical, civil, electrical, mechanical, metallurgical, military, and mining. Civil engineering may be subdivided as shown in Table III.



Interlocking Piling Is Evidently Not a Recent Invention
A Caisson from Ramelli's *Theater of Machinery* Printed in Paris in 1588

There are several bases for the classification of engineering activities besides the professional. We have "civil" or "civilian" engineering as contrasted with "military" engineering. This is a classification on the basis of peace or war. Probably most types of engineering that are useful in peace are also useful in war. The reverse might not be true.

There would also be a third classification based on the time period in the history of mankind. Thus we might have primitive engineering, as in paleolithic and neolithic times. Another type of engineering was associated with the Bronze Age, and yet another with ancient times, as seen in Egypt (building of the pyramids, temples, and obelisks) and in Chaldea. Another type would include the engineering of the ancient Greeks, Phoenicians, and Romans down to the time of Christ and for a few centuries thereafter. The magnificent cathedrals of medieval times would exemplify another distinct period in engineering and architectural activity. Modern engineering would include the period since the beginning of scientific study, and particularly since the invention of the steam engine by Watt.

Table III. Subdivisions of Civil Engineering

Architectural	Geodetic	River and harbor
Bridge	Highway	Sanitary
Canal	Hydraulic	Sewerage
City management	Land and city surveying	Skyscraper
City planning	Landscape architecture	Structural
Contracting	Municipal	Subway
Construction	Railway	Tunnel
Dam and irrigation	Reclamation	Valuation
Drainage	Reinforced concrete	Water supply
Foundation	Research	

Engineering may also be classified from the functional point of view. Such a classification would include:

1. Research—physical, mathematical, or chemical
2. Design—of appliances and machines, of structures, of plants or systems
3. Supervision—over the manufacture of materials, machines, or appliances; over construction, erection, or installation work; or over utility operation
4. Management—of artisans, machine operators, or of a business as listed in (3)
5. Sales—of materials, services, machinery, or publicity

Again, engineering may be subdivided according to the level of work done. For practical purposes the levels of engineering activity may be classified as the manual, the skilled artisan, the technician, and the strictly engineering (the level of creation and direction of engineering works). To perform work of a strictly engineering nature undoubtedly requires ability and training of the highest order.

Geophysical Methods Aid Construction Work

Recent Advances Show Economy and Utility in Exploring Subsurface Conditions

By C. G. Stipe

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and Sherwin F. Kelly

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Although geophysical methods for predicting the position and nature of subsurface formations are not entirely new in America, their application to the service of civil engineers is rather recent—a matter of less than ten years. In the interim development has gone on apace so that now, although it is still young, this field of exploration is well established and used in a variety of construction work. Both seismic and electrical methods are briefly explained in this paper, and then some notable projects are cited. These relate to the location of rock surfaces for dam, tunnel, harbor, and highway construction; the determination of water-bearing strata, including something of the potability of the water; the prediction of soundness in rock formations; and even the location of sand and gravel deposits. Test pits or borings have checked the accuracy of the findings in many instances. These methods are convenient, owing to the lightness and mobility of the apparatus; also they are rapid and hence economical because they are carried out on the surface. These advantages must commend them to the consideration of civil engineers.

Discovery of hidden mineral wealth in the form of metallic ores, gas, and oil, was the first spur to the development of geophysical methods of exploration. The widespread expansion of these techniques on the American continent dates from about 1921.[1] Since the successful geophysical investigation in 1928 at the dam sites of the Fifteen Mile Falls development on the Connecticut River, there has been a growing appreciation and use of these methods, particularly of the electrical one, in the study of proposed dam sites, in highway work, in tunneling, and in water supply problems.

Nearly every civil engineer is frequently confronted with the task of determining the location and nature of subsoil formations. He usually finds it necessary to drill, although this involves considerable expense, and may even require more time than is available. If the desired information can be obtained by geophysical methods, both time and money will be saved. Where local geological conditions favor geophysical methods, the drilling may be confined to checking the crucial geophysical determinations, and to obtaining samples; conversely, the geophysical methods may be used to complete the picture between widely spaced drill holes. To illustrate how such work has actually been of assistance in civil engineering, examples culled from published reports and personal experiences will be cited.

SOME GENERAL METHODS

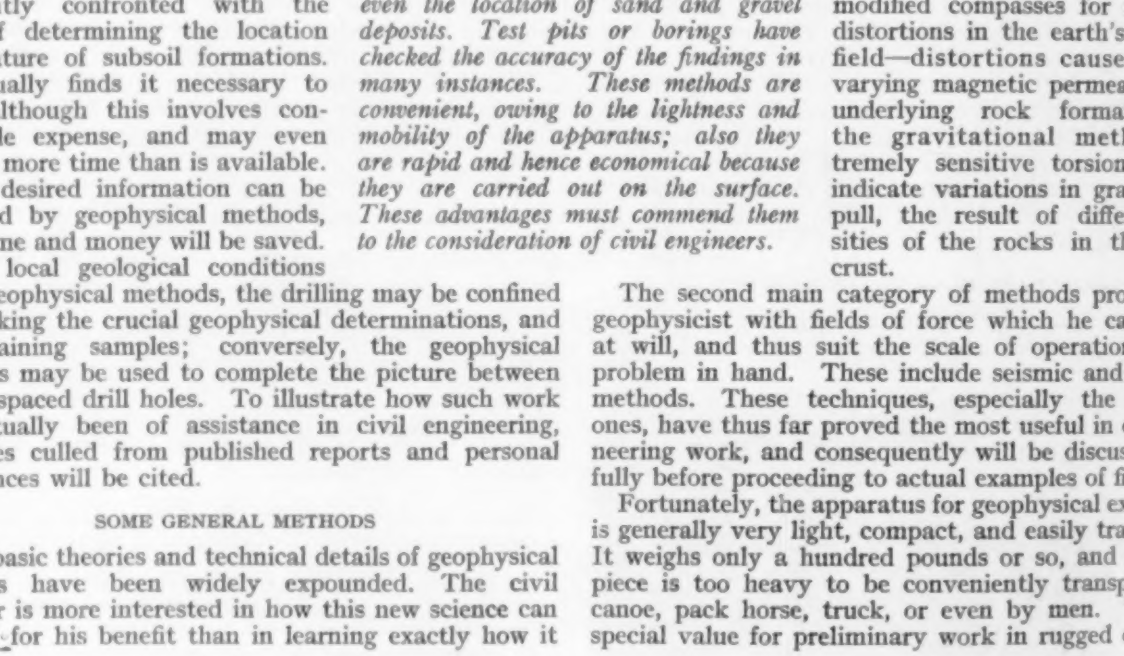
The basic theories and technical details of geophysical methods have been widely expounded. The civil engineer is more interested in how this new science can be used for his benefit than in learning exactly how it works. Nevertheless, he needs some understanding of its principles.[2]

Differentiations of geological structure by geophysical means can be achieved only where the formations being studied show distinctive differences in certain physical properties. The choice of geophysical method will therefore depend on which properties shown by the formations present sufficiently great variations, as in magnetic permeability, density, electrical resistivity, and elasticity. In certain methods, the geophysicist depends on observations of fields of force natural to the earth itself, and therefore beyond his control to modify. These are the magnetic and gravitational methods. In the former, he uses modified compasses for measuring distortions in the earth's magnetic field—distortions caused by the varying magnetic permeabilities of underlying rock formations. In the gravitational methods, extremely sensitive torsion balances indicate variations in gravitational pull, the result of differing densities of the rocks in the earth's crust.

The second main category of methods provides the geophysicist with fields of force which he can control at will, and thus suit the scale of operations to the problem in hand. These include seismic and electrical methods. These techniques, especially the electrical ones, have thus far proved the most useful in civil engineering work, and consequently will be discussed more fully before proceeding to actual examples of field work.

Fortunately, the apparatus for geophysical exploration is generally very light, compact, and easily transported. It weighs only a hundred pounds or so, and no single piece is too heavy to be conveniently transported by canoe, pack horse, truck, or even by men. This is of special value for preliminary work in rugged country.

Fig. 1. Geophysical Results and Drill Findings Compared, Masson Project on Lièvre River, Canada



Seismic methods make use of earth vibrations set up artificially. The earth waves are reflected or refracted back to the surface by subsurface rock formations, whose elastic properties give them speeds of wave transmission higher than those of the overlying materials. The wave motion is usually created by an explosive, and the recording instrument is some type of portable seismograph. From the time required for disturbances to travel the known distance from the source to the receiver, conclusions may be drawn regarding the nature and depth of the underlying formations.

LOWER DAM AT FIFTEEN MILE FALLS, CONNECTICUT RIVER NEAR LITTLETON, N.H.
Site Where Geophysical Prospecting Methods Were First Used in America on a Civil Engineering Project

BASIS OF ELECTRICAL DETERMINATIONS

Electrical methods are perhaps the most useful and dependable in the civil engineer's preliminary investigations. All types depend on the fact that the various materials of the earth's crust offer different degrees of resistance to the flow of an electric current or to the transmission of electric waves.

An electric current flowing through homogeneous ground will distribute itself according to a known and distinctive pattern. This distinctive pattern will be distorted, however, if there is a mass present which is more resistant or more conductive than the adjacent materials. In the case of a resistant mass, a large part

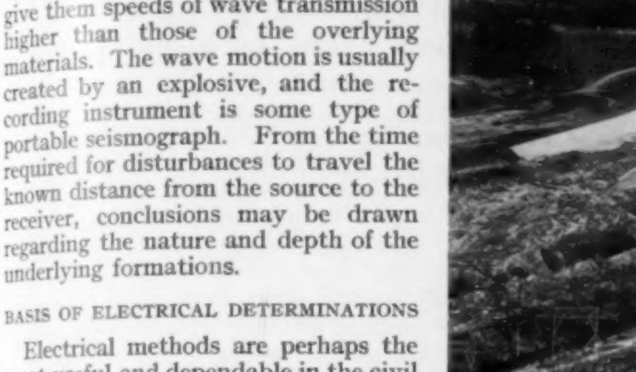


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FIG. 2. ELECTRICAL SURVEY FOR TUNNEL CHECKED BY LATER EXCAVATION, BRIDGE RIVER PROJECT

of the current tends to avoid it and thus produces an abnormally high concentration of current in the adjacent or overlying materials. Conversely, with a conductive mass, the flow of electricity tends to be concentrated in the more conductive material, leaving a deficiency of current in the surrounding formations. The most usual condition encountered when studying the depth to bedrock is that the overburden is conductive, and the bedrock highly resistant. Electrical methods are ruled out only under the rare condition when overburden and bedrock are equally conductive.

Various types of bedrock also vary in their electrical resistivities; as a general rule igneous rocks have a considerably higher electrical resistance than the sedimentary ones. Of the sedimentary rocks, sandstones and limestones are more resistant than shales and clays. When a compact rock, either igneous or sedimentary, is traversed by a fractured or shattered zone saturated with water, such a zone will show abnormally low resistance. The same also applies to weathered parts containing moisture. As a matter of fact, the electrical conductivities of soils and rocks are usually functions of their moisture content.

In order to obtain the resistance of subsurface formations, an electric current is passed through the ground, and the strength of the ground current is measured at various points. The power source and the measuring circuits are connected to the ground by means of short metal pegs driven a few feet into the earth. The spatial relationships between the points of observation and the contacts through which current is supplied to the ground, provide the data for calculating resistivities, and for determining whether these calculated values refer to near-surface or to buried formations.[3]

In general, engineering projects adaptable to these methods, particularly preliminary investigations, fall into two general categories. In the first, the depth to a given horizon, such as bedrock, or a water-bearing stratum is needed; in the second the physical characteristics of subsurface formations are determined.

DEPTHS DETERMINED AT FIFTEEN MILE FALLS

The New England Power Association project at Fifteen Mile Falls on the Connecticut River near Littleton, N.H., was the site in 1928 of the first practical application of electrical methods to the study of bedrock depths. Two dam sites, about eight miles apart, were studied. In this region a deeply buried preglacial gorge winds from side to side beneath the present valley floor. The bedrock is covered by glacial deposits of boulder clay, gravel, sand, and clay, and consists largely of Pre-Cambrian schists, resulting from the metamorphism of ancient sediments and lavas. There are occasional intrusions of granite and trap into these schists. Drilling through the overburden proved slow and expensive because of many boulders. Consequently, electrical methods of depth determination were used to supplement the drilling, so as to accelerate the work and cut the cost.

In planning the construction of the dams, the position of the buried gorge was of importance. The possibility that it might leave the valley entirely presented the danger of leakage from the reservoir at points distant

from the dam site. At the lower site, electrical prospecting revealed that the gorge lay under the left bank of the river several hundred feet from, and 50 ft deeper than, the present river bed, with an overburden of 300 ft; and that the larger part of the tailrace excavation would not encounter bedrock.

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ELECTRICAL APPARATUS IN USE ON ALGIERS HARBOR SURVEY OF WATER-COVERED AREAS

Geophysical Method Obviates Costly Mechanical Drilling

Confusion may result if the overburden and bedrock do not differ in their electrical resistivities, as was shown in this work. An electrical determination indicated a hill of resistant material in the middle of the buried gorge. On geological grounds it was improbable that this could be bedrock, so a hole was drilled to check the findings. It showed that the hill consisted of gravel and boulders instead of bedrock, and that the electrical indications gave accurately the depth to this formation. Hence geophysical results should always be studied in the light of geological evidence. On the survey as a whole, later drilling and excavation proved the essential accuracy of the bedrock contours as electrically predicted.[4]

CANADIAN RIVERS STUDIED

In 1929 a survey was made for the James Maclaren Company near Masson, Quebec, on the Lièvre River, a tributary of the Ottawa. From the desired dam site, water was to be diverted to the power house by a tunnel nearly a mile long. Electrical exploration gave a quick survey of the territory along the proposed tunnel, in an endeavor to ascertain whether there was a sufficient cover of solid rock for safe construction. Upon this survey would depend the location of the dam as well as that of the tunnel itself.

Work was carried out at 63 stations about 200 ft apart, plus 12 determinations on the opposite bank of the river. As a result, the location of the tunnel was definitely decided upon, and in 1930 twenty drill holes were made along this line. The results from the drillings checked very satisfactorily with the electrical predictions, as shown in Fig. 1.

A similar study, this time to find suitable dam locations, on the St. Lawrence River near Morrisburg, Ontario, had to be made with all possible speed in the spring of 1929 for the Department of Railways and Canals of Canada, in order to orient subsequent drilling. The underlying rock consists of nearly flat-lying beds of limestone, with some shale. The overburden is mostly boulder clay.

Over a hundred determinations were made, or about one to the acre. On drilling, the average error of the electrical predictions was found to be only 6.6 per cent, a most satisfactory result considering that the contour of the bedrock is not at all regular.

On the Lièvre and St. Lawrence River projects, a total of 176 depth determinations were made in 63 1/3 working days, giving an average of 2.8 determinations per day at a cost of about $60 per determination.[5]

ALGIERS HARBOR ILLUSTRATES MARINE SURVEY

It is possible to determine bedrock contours even under water-covered areas, as shown by the survey made in 1932 in connection with plans to alter and enlarge the harbor at Algiers. As a preliminary to the construction of piers, wharves, and breakwaters, it was necessary to determine the elevations of the bedrock, which consists of crystalline schists covered by variable and unknown thicknesses of mud and other sediments. Mechanical drilling might have been employed, but such work at sea is relatively laborious and slow. Furthermore, the information gained is purely local and does not give a general idea of the underlying topography unless many holes are drilled. Consequently, it was decided to utilize electrical and mechanical methods simultaneously.

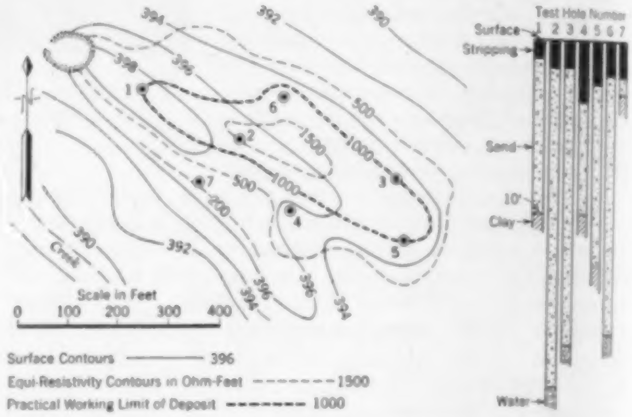

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FIG. 3. LOCATING SAND DEPOSITS FOR ROAD BUILDING

Geophysical Method Proved Successful in Minnesota by Later Test Holes (From Unpublished Manuscript by Stanley Wilcox)

The electrical measuring apparatus was set up on shore, and the cables for making electrical contact with the harbor bottom were dragged into position by boats. Measurements were then made along 11 alignments. The results were found to check satisfactorily with the test drill holes later put down. For example, one alignment gave electrical depth determinations averaging from 4.5 to 6.5 m; a drill hole on this alignment showed the sediments to be 5 m thick. The particular economic advantage of this survey was the fact that it obtained a large number of depth determinations speedily and at a low cost.[6]

USED ALSO IN HIGHWAY WORK

This electrical method has also been tested on bridge-site locations. In cooperation with the Missouri Geological Survey the Megger ground tester was used on two locations in that state—at Gasconade Bridge, Route 63, and at Roubidoux Bridge, Route 66—where the depth of overburden was known from drill records. The fact that the electrical observations checked the drill records and that the work at each place occupied but a couple of hours is worthy of note.[7]

In addition, the Missouri State Highway Department uses the electrical method of determining overburden

to ascertain quickly the relative amounts of rock and soil that must be excavated. It has been stated verbally that contracts have been awarded on this basis.

Seismic apparatus for shallow depths has been developed, and is reported to have had successful trials in rapidly determining the depth of overburden along proposed highway cuts.[8]

DETERMINING WATER-BEARING HORIZONS

The technique of electrically obtaining the depth to a given stratum, or to bedrock, can solve problems of water supply. A fairly obvious application is to determine the position of a bedrock channel covered by thick deposits of alluvium. In such a channel, especially in desert valleys, frequently an underground flow can be tapped for domestic or commercial use.

Another problem is concerned with the depth of a given water-bearing stratum. For example, at Biarritz on the French coast it was desired to map the contours of the impermeable stratum underlying a water-bearing sandstone covered by Quaternary alluvium. Reconnaissance showed two zones to be of interest. Detailed depth determinations were then made, of which the following are typical. Six determinations showed an average depth to the underlying impermeable stratum of 29.8 m. Well drills at nearby points gave an average depth of 31.5 m. The maximum error was 4 m. In another region, a nearly uniform depth of about 40 m was predicted, and the drills struck rock at 33 to 43 m.[9]

Much more complicated problems can be solved electrically, as demonstrated in Palestine, where the recent intensifying of agricultural development made it imperative to increase the water supply. Many costly and unsuccessful borings had failed to discover the requisite quantities of water, with the result that it was decided to utilize geophysical methods in conjunction with geological studies.

The geophysical work was directed towards the study of structural features that would affect the accumulation and the quality of the water. Porous strata capable of yielding water were located; folds in which water could accumulate were delineated; faults competent to trap water were traced; and by studying the dip and strike of permeable and impermeable strata, it was found possible to predict whether or not a given aquifer was open to contamination by sea water. The strata included limestones, sandstones, marls, and clays underlying both plains and mountains. Surveys have been carried out in all districts of Palestine, the depth determinations involved ranging from 50 to 600 m.[10]

ON FIFTEEN MILE FALLS SURVEY, OPERATOR IS READING POTENTIOMETER MOUNTED ON TRIPOD

Dry Cells and Reel of Wire Also Ready for Use

A statement has been made that 94 per cent of the wells drilled on geophysical recommendations disclosed water at the predicted horizons. Wells drilled against the advice of geophysicists have practically all been unsuccessful. These results make a striking comparison with the poor showings prior to 1933, the year geophysical methods were first used in such work. At that time only 32 per cent of the borings had been successful in obtaining water in an adequate quantity.

INSTRUMENTS FOR TESTING MISSOURI BRIDGE SITE

Compact and Portable Features Are Evident

TO REVEAL CHARACTER OF FORMATIONS

As previously mentioned, shattered zones or weathered formations saturated with water would show abnormally low resistivities. One of the earliest applications of electrical methods in construction work for predicting this type of rock condition, was made in 1928 on the Bridge River project of the British Columbia Electric Railway Company. A tunnel 13,200 ft long was being driven through a syncline of sheared greenstone, so that both headings were in the same horizon, the rocks dipping inwards at an angle of 45 deg. The rock first encountered was rather firm, containing many fissures, but little water. In the north heading, the work proceeded satisfactorily. In the south heading, however, the greenstone became much softer and more fractured about 1,020 ft from the tunnel entrance. At 1,220 ft, a strong flow of water invaded the tunnel, crushing the timbering and causing a complete collapse over a length of 200 ft. Consequently the end of the drift had to be bulkheaded and abandoned.

It was planned to drive an offset tunnel around this abandoned drift, but first, in order to determine what new conditions would be encountered, an electrical exploration was made (Fig. 2) in which the shattered and water-saturated zone was clearly outlined by areas of low resistivities, the water being a good conductor because of content of salts. On this basis it was stated that "approximately from point 1,190 to point 1,560 the drift will cross a bed of particularly soft material; a bed of harder rock will then be encountered...but it is not until point 1,730 that conditions similar to those encountered before point 1,020 can be expected."[8]

Subsequent tunneling showed that the conditions actually encountered were essentially those predicted by the geophysical survey. Thus the contractor was forewarned of difficulties and enabled to take precautions which permitted him to traverse the dangerous ground with safety and success.

As another illustration, a concrete dam was being built on LaTruyère River in France on granite which showed normal surface weathering and contained some wet, fractured zones. Electrical studies were made on the surface and in drill holes to learn if the location of such zones, or the depth to sound and impermeable rock,

could be predicted. A close correspondence was found between the electrical resistivities and soundness. Where the granite was uninjured, the resistivities were high. Where low resistivities were encountered, the rock was either broken or not sound, and therefore more or less permeable. It was also found that the

ELECTRICAL EQUIPMENT USED BY ILLINOIS STATE GEOLOGICAL SURVEY IN GEOPHYSICAL PROSPECTING FOR GRAVEL DEPOSITS

thickness of the weathered zone was readily determinable electrically, thus indicating the depths at which the sound rock would be encountered.[11]

IN GRAVEL AND SAND DEPOSITS

Evidently water-bearing areas in fractured or shattered zones can be determined. Of more importance however, is the location of gravel bodies containing potable water. Geophysicists of the U. S. Bureau of Mines have demonstrated the value of this type of work in some desert areas of Nevada. Where gravel bodies are enclosed in alluvium or clay, the latter will usually show much lower resistivities. In spite of the fact that the gravels contain water, they are usually highly resistant because that water, if potable, contains practically no salts in solution and is therefore not an electrolyte. Observations on glacial deposits, or on alluvial deposits of valley or plain, indicate water-bearing gravels by areas of high resistivity due to an absence of salts in solution. By this means water supplies adequate to irrigate a moderate sized ranch have been found in gravels at fairly shallow depths in desert areas where no surface indications, such as vegetation, would indicate their occurrence.[12]

These same technicians performed a valuable service to the city of El Paso, in connection with salt water invasion of a city water well when, on the basis of resistivity measurements, they were enabled to differentiate the areas in which fresh water would or would not be found in an underlying water-bearing horizon. In Hawaii, the depth at which salt water, underlying fresh water, would invade prospective wells was determined.

In Minnesota, electrical studies are used to locate sand and gravel for road-building purposes. These materials are found in glacial deposits, and not infrequently are evident as slight ridges or elevations. At the site in Fig. 3 the topography, and the old, worked pit in the upper left corner, led to the conclusion that more sand should be found under the ridge. As the sands are more electrically resistant than the surrounding clays and soils, the lines enclosing those areas of high resistance are indicative of the extent of the sand underlying the surface soil. In this case, the heavy line enclosing the area of more than 1,000 ohms resistance shows that the concealed sand lies north of the ridge. Test holes, as shown in the diagram, proved the correctness of this prediction. The electrical survey took less time than was required to make one deep pit.[1] In other cases, by combining depth measurements with surface plans, it has been found possible to estimate correctly the approximate yardage of sand and to show what parts contained the right proportion of clay overburden for a good mix.

A WIDE FIELD

From the foregoing it is abundantly evident that the geophysicist can render important aid to the civil engineer in many types of construction work. At the present time, the rôle of geophysics has been principally in the field of dam construction, highway building, and water supply. There are probably other fields, however, to which geophysical methods could be adapted, either by using present techniques, or by developing new procedures applicable to hitherto untried problems.

This article has been written with the idea of calling to the attention of those unacquainted with geophysical methods the advantages which may accrue from the utilization of these techniques. It is also hoped that civil engineers will consider the possibilities of utilizing the geophysicist and his methods in new problems where it is essential to study the location and character of subsoil formations.

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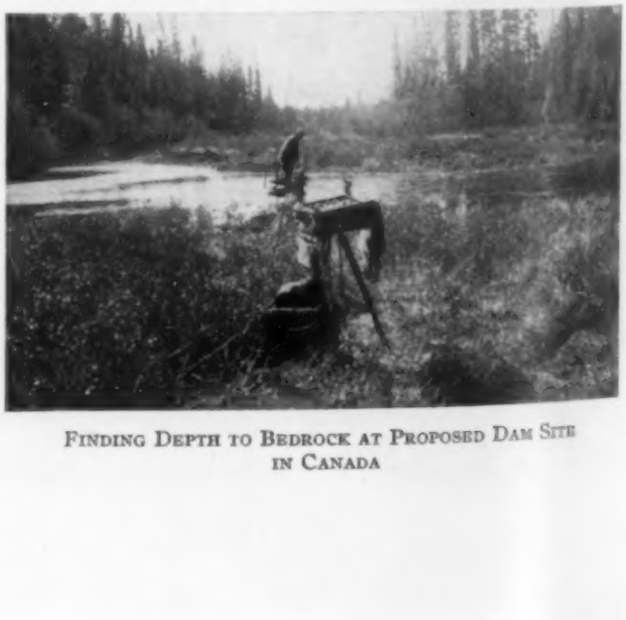


FINDING DEPTH TO BEDROCK AT PROPOSED DAM SITE IN CANADA

The Osaka Underground Railway

Subway Construction Under Difficult Conditions in Japanese City

By Y. Totake

Consulting Engineer, Tokyo Underground Railway Company, Tokyo, and the Transport Board of the City of Osaka, Japan

In 1930, the Transport Board of Osaka, most populous city of Japan, began construction of a two-track high-speed transit rail subway. In 1935, two and one-half miles of subway were in operation, and construction of an equal length of new line was being actively pushed. Under the circumstances progress was good, although with favorable soil conditions it could not have been so considered. It was necessary not only to carry the subway structures under numerous rivers and canals, but also to construct waterproof bulkheads in certain locations far from watercourses to avoid loss of water-borne silt from behind the sheeting. The methods developed to meet these conditions are interestingly presented by Mr. Totake in the following article. Acknowledgment is made of the assistance of Robert Ridgway, Past-President of the Society, in preparing the abstract for publication. For information on other subway work in Japan, reference may be made to Mr. Totake's interesting article, dealing with the Tokyo system, published in the November 1935 issue.

Osaka, lying at the mouth of several branches of the Yodogawa and facing the Gulf of Osaka (Fig. 1), is the largest city and commercial center in western Japan. Its activities embrace many lines of business. Because of its numerous canals it is known as the "City of Canals and Bridges," and some of the bridges are noted for their architectural beauty. A castle built in feudal times still remains in Osaka Park as a memorial to a past age, and as an example of ancient Japanese castle architecture. The visitor to Osaka Castle, which stands on an eminence far above the inland sea, is amazed at the enormous size of the blocks of stone used in its construction and wonders how the builders of those relatively primitive times could have transported such stones up the hill from the quarries to the site.

The first tram-car line in Osaka began to operate in 1903, and since that time the lines have been extended year by year. There is a double-track municipal tram-car line 104 km (65 miles) long and many municipal and private bus lines and taxicabs, but these facilities cannot begin to satisfy the transportation requirements of the city's 2,500,000 population.

A planning study for future city developments, begun in 1918, included a rapid transit railway system of ample capacity to care for the traffic needs of the present and the near future. The municipality planned to provide, through the medium of public loans, subway routes through the center of the city and elevated lines in the suburbs, covering in all about 50 km (31 miles) of route, and after long discussion this plan was finally adopted in 1925. At that time the late Dr. H. Seki was mayor of Osaka, and H. Shimizu was chief engineer of the city's Transport Board. The first standard design and the construction of the first section of the subway were carried out by Mr. Shimizu, who retired in 1935 and was succeeded by K. Hashimoto.

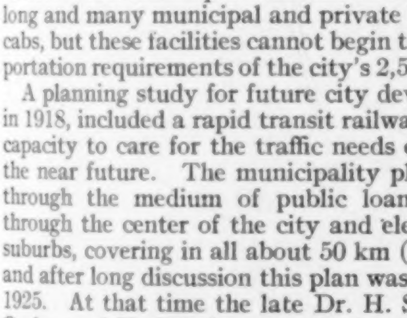
In 1930 construction of Route 1 (Fig. 2) was begun at Umeda, and continued towards the center of the city. It is at Umeda that the Osaka station of the government's trunk-line steam railway is located. The section from Umeda to Shinsaibashi, 3 km (1.9 miles) long, was opened for traffic in 1933, and the next section, to Namba, was completed and placed in operation in 1935, making a total of 4.2 km (about 2.6 miles) of line in operation, with five stations. Succeeding sections towards Tennoji, and Route 3, a branch line 4.1 km (2.5 miles) long to Sumiyoshi, are under construction.

Namba, a shopping center of Osaka, is the terminal of the Nankai Electric Railway to Wakayama City, and along that line there are many beautiful summer resorts and famous bathing beaches. Beyond Tennoji there is a residential section, and here the subway becomes an elevated line. The Sumiyoshi line, which has its terminus at a large city park, is a subway.

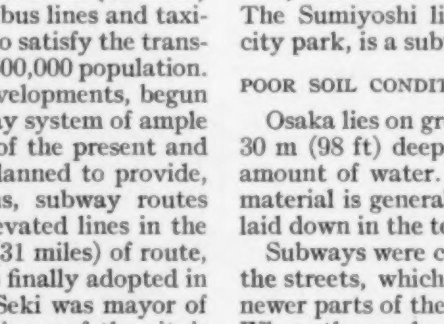
Poor Soil Conditions Hamper Subway Construction

Osaka lies on ground composed of river-deposited sand 30 m (98 ft) deep, on a gravel layer, containing a large amount of water. In the neighborhood of Tennoji the material is generally hard clay and water-bearing gravel laid down in the tertiary period.

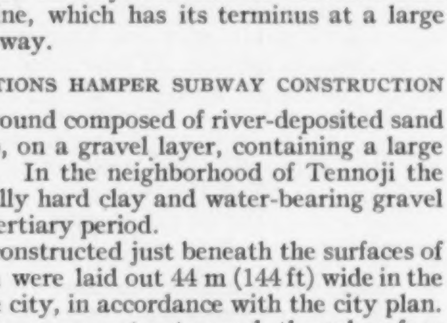
Subways were constructed just beneath the surfaces of the streets, which were laid out 44 m (144 ft) wide in the newer parts of the city, in accordance with the city plan. Where the roadways were not yet paved, the subsurface pipes and ducts were located so as to simplify subway construction as much as possible. Although the sub-



Constructing Subway Under a Watercourse; Steel Framework Omitted Elsewhere



Applying Asphalt Fabric Over Brick Set in Mastic on Outside of Structure



Finished Subway, Showing One Track With Third Rail and Duct Racks

Stages of Construction, Rectangular Cross-Section, Osaka Two-Track Subway

FIG. 1. GENERAL MAP SHOWING LOCATION OF CITY OF OSAKA

ways are located as near the surface as possible, the necessity for crossing under many waterways made it necessary to vary the depth of cover over the roof from 3 to 8.5 m (10 to 28 ft).

The open-cut method of subway construction was adopted. At first it was planned to support the sides of the excavation either by vertical I-beam soldier beams with wood sheeting, or by steel sheet-piling along each side of the trench. The soil in this section is generally fine sand with a small quantity of clay carrying a large amount of water. Under these conditions, the usual I-beam soldier-pile construction was not considered suitable, as it was feared that during excavation the ground water would flow, carrying with it much fine sand with resulting loss of ground and damage to adjacent private property on both sides of the street. The steel sheet-pile method was therefore finally selected.

During excavation, transverse wooden struts were set between wooden wales on the inside faces of the steel sheet-piles. The struts were spaced in general 3 m (10 ft) vertically and 2 m (6.5 ft) horizontally. Excavated earth was lifted out by hoists.

The subway structure, containing two tracks, has a rectangular cross-section of reinforced concrete, enclosed with brick in mastic and asphalt fabric waterproofing. Its clear height is 4.9 m (16.1 ft) and its width 4.0 m (13.1 ft) for each track. The space over the roof was backfilled with earth, and the steel sheet-piles were removed for further use. After the customary period of settling the fill had elapsed, the permanent street paving was laid.

STATION PLATFORMS OF THE ISLAND TYPE

All subway stations have island platforms, at both ends of which mezzanine floors are provided, with ticket rooms and toilet rooms. The mezzanine extends the whole length of Namba station. At both ends of the island platforms, escalators are provided, in addition to stairs, for the use of passengers. Exit and entrance stairways lead from the mezzanine floors to the street surface. The platforms are 600 ft long, providing space for 10-car trains.

Exhaust and blow fans having a capacity of 200,000 cu m (about 7,000,000 cu ft) per hr are provided at both ends of the stations and halfway between stations for ventilation in case of emergency.

The track gage is 4 ft $8^1/_2$ in. The rail is flat-bottomed, weighs 100 lb per yd, and comes in sections 15 m (49 ft) long. The rails are fastened to sleepers with screw spikes through tie plates. The track bed is of broken-stone ballast except at stations, where the short wood blocks used for sleepers are embedded in concrete. Rail joints are welded so as to form sets of four rails each, in order to lessen the sound of the cars. On curved tracks and at stations, head-hardened rails are used.

Three-position, color-light, automatic block signaling with an overlap section is employed, and automatic train stops are provided. Interlocking switches at crossovers are actuated by electro-pneumatic mechanism.

Cars are of steel, are $17^1/_2$ m (57.5 ft) long, and weigh 45 tons. They are each provided with two motors of 230 hp, dynamic and air brakes, automatic couplers, and doors pneumatically operated. At present two-car trains are running at 3-minute intervals.

Alternating current, at 22,000 v, is provided by two different sources from Umeda substation, where it is transformed by means of rotary converters and transformers. In addition, storage batteries are provided for lighting in case of power failure. Power is transmitted by a third rail of the upper-contract type delivering direct current at 750 v. The power rail weighs 150 lb per yd and is similar in type to that used on the Independent Subway System in New York.

As the Tennoji line and the Sumiyoshi branch line are located in the busy central part of the city, there was no

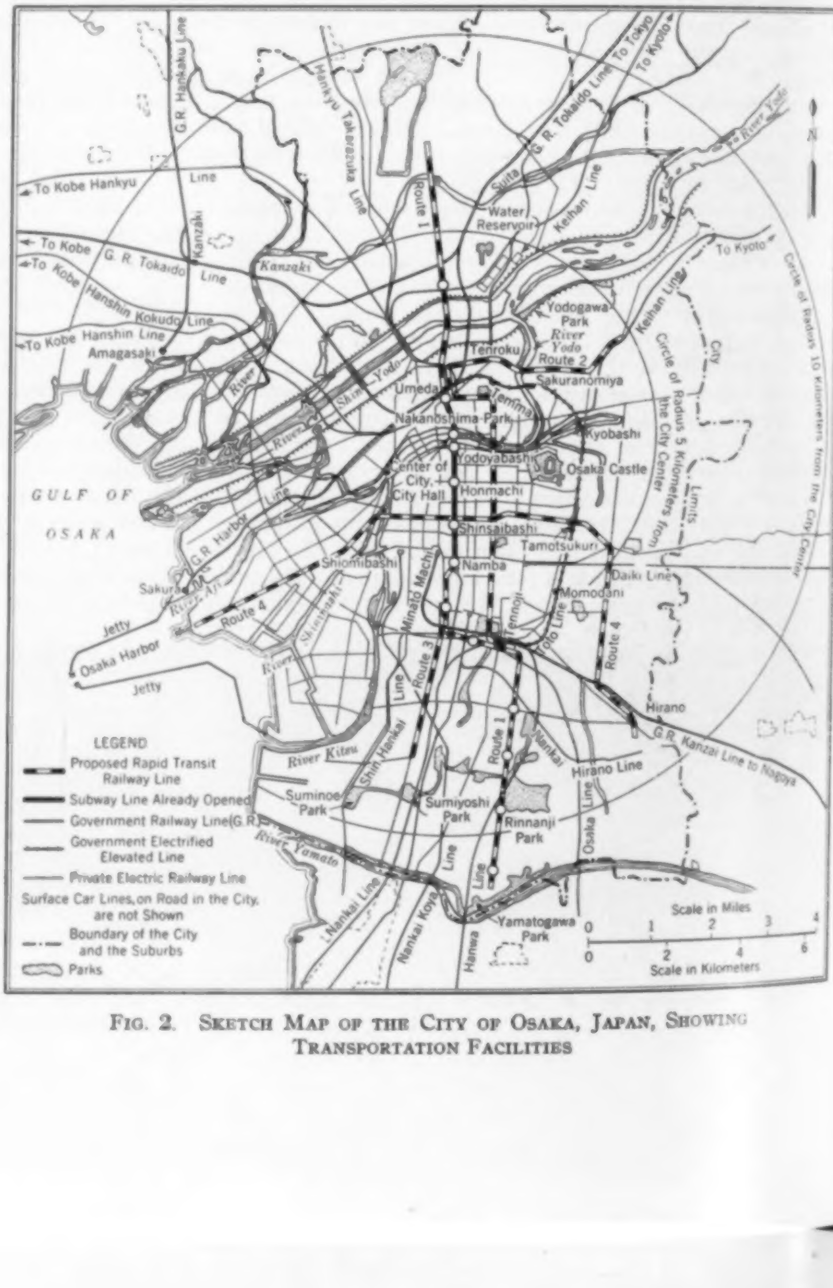


FIG. 2. SKETCH MAP OF THE CITY OF OSAKA, JAPAN, SHOWING TRANSPORTATION FACILITIES


THE ŌE HIGHWAY BRIDGE OVER THE DOJIMA RIVER, CONSTRUCTED ABOVE THE SUBWAY

place for a car shed on the surface. On this account it was necessary to lower the cars from the street to the subway by means of derricks and to use one end of a station as a temporary repair shop and car depot. Temporary siding tracks were laid for that purpose. The permanent car depot and repair shops are later to be built in the suburbs on an elevated part of the line.

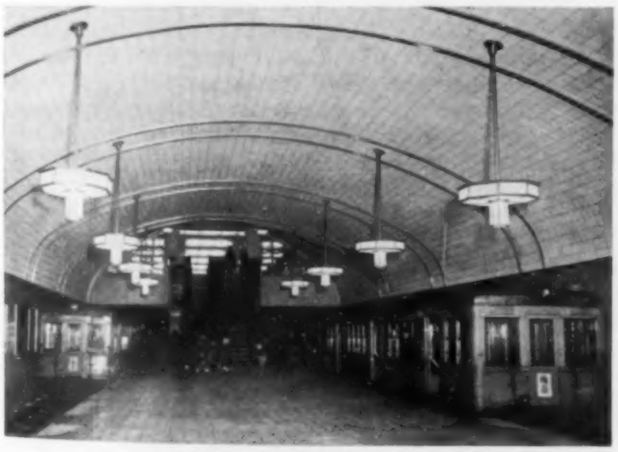
For the new sections referred to, the open-cut method of excavation with I-beam soldier piles is being used, the nature of the soil being suitable. For part of the way a cross-section with an arched roof will be used for the two-track structure, which is to be built either in open cut or in tunnel. Moreover, a caisson method employing compressed air is to be tried out experimentally.

CROSSINGS AT WATERCOURSES

The Umeda-Namba section of the subway crosses two rivers and one canal, and at these points special methods were required. The width and depth of these waterways are as follows:

Waterway	Width of Waterway	Depth of Waterway
Dojima River	90 m (295 ft)	2.7 m (9 ft)
Tosabori River. . . .	65 m (213 ft)	3.6 m (12 ft)
Nagahori Canal . . .	28 m (92 ft)	3.3 m (11 ft)

At the Dojima River a highway bridge composed of two flat arches with an opening in both abutments is be-


THE PLATFORM AT SHINSAIBASHI STATION

ing constructed simultaneously with the subway. This bridge is a part of the road improvement work for which the Osaka city plan provides. Parts of the bridge abutment and pier foundation close to the tube are being built as units with the subway structure, but in order to ensure the safety of both structures, clearance has been provided between the bridge foundations proper and the tube.

Steel sheet-piling was driven along the outer sides of the subway structure and of a part of the southern foundation of the bridge abutment, occupying about 42 per cent of the width of the waterway. When the excavation was finished, the rectangular-shaped double-track subway was constructed with a middle partition wall of reinforced concrete containing a supplementary braced steel frame. After excavating trenches on both sides of the tube, the foundation columns for the bridge abutment were concreted up to the top of the subway structure. A transverse cover of reinforced concrete was placed on the foundation columns and over the subway to carry the bridge abutment. When this first section had been completed, the stream was diverted over it and the rest of the tube was constructed in a similar way, except that the pier and abutment foundation columns were built by the caisson method with compressed air. This change of procedure was made on account of an accident attributable to the sheet-pile method, which had occurred in the interim at the Tosabori River crossing.

During the time when the waterway was restricted, the stream velocity was increased considerably, especially at ebb tide, and a steam launch proved necessary to help barges through the narrow channel.

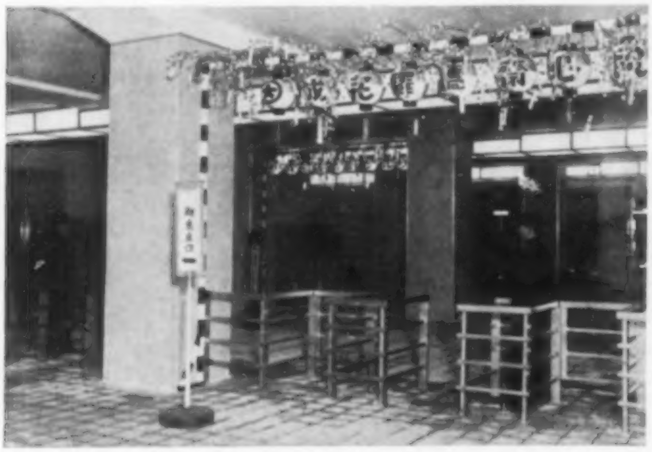
At the crossing of the Tosabori River a highway bridge with a single flat arch was built. The subway was constructed by the same general method used at the Dojima crossing. Two of the foundation columns were built in the open by the use of steel sheet-piling, and the other two columns were constructed by the caisson method with compressed air.

During the work on the northern, or first section, an accident occurred. The bed consists of a deep layer of clay and coarse sand containing a large amount of ground water. Excavation for the foundation column on one side of the tube had been carried on successfully. When similar excavation on the opposite side had progressed to the intended depth, somewhat lower than the bottom of the subway structure, water burst in at the bottom, breaking the sheet-pile bulkheads and allowing the river water to flood the tube. Profiting by this experience, the engineers used the caisson method in placing the foundation column on the opposite side of this working section and in part of the work at the Dojima River crossing, as previously described. At the Nagahori Canal crossing, the subway was built inside a steel sheet-

pile cofferdam constructed directly across the waterway and temporarily blocking it.

CONSTRUCTING THE UMEDA STATION

The Umeda subway station lies beneath the Osaka station of the government trunk-line railroad, which traverses Honshu, the principal island of Japan, from Tokyo to Shiminoseki. At the time it was being built the railroad line was undergoing reconstruction as an elevated structure through the city of Osaka. At the Umeda station, which serves Routes 1 and 2, the subway structures each consist of a series of semicircular arches, enclosing two tracks and an island platform 9 m (29.5 ft) wide, with a mezzanine at the middle and another at the south end where the tunnel is rectangular in shape. Two of the four tracks were to be used for Route 1 and the other two for Route 2.



THE MEZZANINE FLOOR AT SHINSAIBASHI STATION

Since the high-level station of the steam railroad extends over about half the length of the subway station, it was necessary to build the northern part of the underground structure first, so that the construction schedule for the subway would fit in with that for the railroad station. The elevated structure of the latter crosses over the subway on two plate-girder spans which rest on abutments and piers, supported in turn on the side and center walls of the underground arch. The site of the north part of the subway station was vacant. After the elevated structure had been completed, the railroad tracks were raised from the ground surface to their new position, clearing the site for the remainder of the subway work.

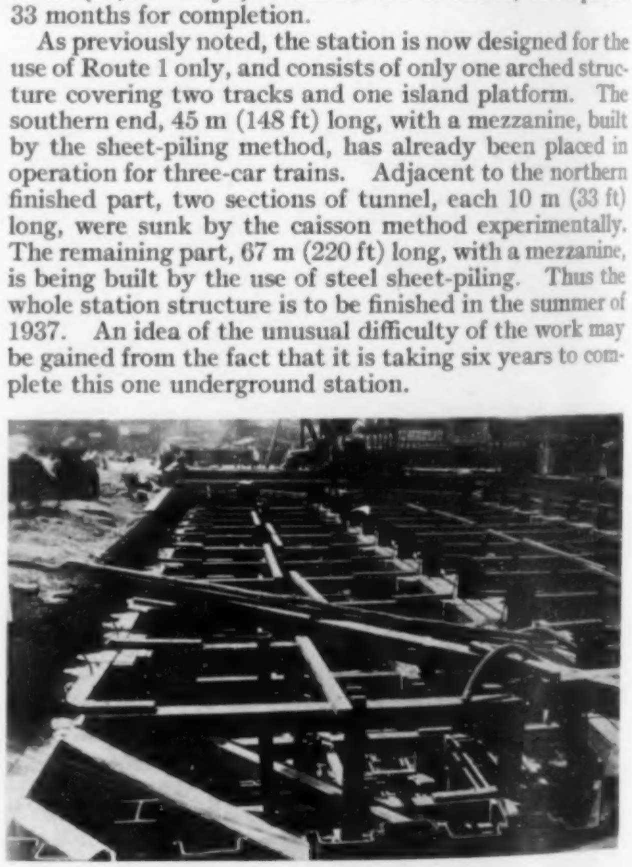
This north part of the underground station required an excavation 40 m (131 ft) wide, 17 m (56 ft) deep, and 70 m (230 ft) long. The original plan was to excavate the ground 4 m (13 ft) deep with slopes on both sides; to drive steel sheet-piles at the bottom of the pit along both sides of the proposed structure; and then to excavate to the required depth, leaving an earth slope on each side of the deeper excavation as well. A part of the invert of the station structure, with a central wall to support the two arches, was to be built; then the sloping earth within the sheet-piles was to be excavated and the structure completed. But as the soil was composed of very fine sand, like silt, with a small quantity of clay and containing 40 per cent of water by weight, enormous pressures were exerted on the sheet-piles, causing many cracks and depressions behind them. Devices for lowering the ground water proved unsuccessful on account of the extreme fineness of the sand, and the entire plan had to be abandoned.

After several methods had been tried, the following means proved successful. When sheet-piles had been driven along the outer edges of the station structure, I-beam piles were driven in two lines, dividing the enclosed space longitudinally into three parts, for construction of the two side walls and center wall, respectively. One of the side thirds was later abandoned when it was decided not to build the Route 2 half of the structure. Transverse struts were next placed to brace the sheet-piling, as shown in one of the photographs. Each of the other two parts was then excavated separately, and the wall and invert of that part built. The arch was constructed last.

The inverts are supported on wood foundation piles 12 m (39 ft) long. The piles could not be driven after excavation was completed because it was found that the accompanying rise of the earth surface would displace the transverse struts between the sheet-piles. Therefore it was necessary to drive long piles in the pit during the excavation, leaving their tops about 7 m (23 ft) higher than the intended bottom of the structure. After the pile driving was finished, excavation was completed to the design depth, and the tops of the piles were cut off. The ground-water pressure was so great that at this point water oozed out around the tops of the piles. It was found that the pile tips had penetrated the gravel layer, which contained water under high pressure. On one occasion in the course of the work, ground water laden with fine sand bubbled up suddenly out of the sump. It was found that cavities had formed behind the sheet-piles and had damaged a part of the elevated structure behind them.

In spite of the fact that this part of the work required only 54,000 cu m (70,600 cu yd) of excavation and 15,400 cu m (20,100 cu yd) of reinforced concrete, it required 33 months for completion.

As previously noted, the station is now designed for the use of Route 1 only, and consists of only one arched structure covering two tracks and one island platform. The southern end, 45 m (148 ft) long, with a mezzanine, built by the sheet-piling method, has already been placed in operation for three-car trains. Adjacent to the northern finished part, two sections of tunnel, each 10 m (33 ft) long, were sunk by the caisson method experimentally. The remaining part, 67 m (220 ft) long, with a mezzanine, is being built by the use of steel sheet-piling. Thus the whole station structure is to be finished in the summer of 1937. An idea of the unusual difficulty of the work may be gained from the fact that it is taking six years to complete this one underground station.



EXCAVATION AT UMEDA STATION, SHOWING BULKHEADS, I-BEAM PILES, AND HEAVY BRACING

Map Makers and Map Users

Need for National Mapping Program Accentuated by Increasing Public Use

By WILLIAM BOWIE

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CONSERVATION work, construction operations, and long-term planning projects could all be carried on more effectively if good maps were available. In addition, employment would be given to many engineers, since untrained personnel can no longer produce acceptable maps. These are a few of the reasons why a national mapping program should be pushed, says Dr. Bowie in the accompanying article. Passing next to surveying methods, he outlines modern procedure in map-making, which utilizes aerial photography in addition to the plane table and the older surveying instruments. This well-reasoned and instructive article concludes with a description of the national control surveys, including the basic considerations involved in making them and the various important uses for the resulting data.

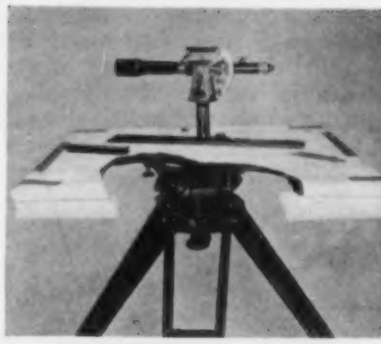
MUCH has been said in recent years about maps and their uses, but very little has been done about them. It is generally recognized that a knowledge of the terrain is absolutely essential for the proper conduct of many lines of human activity. In spite of this, the United States is one of the most poorly mapped countries in the world. Probably this is due to an abundance of land and resources and a plethora of money with which to carry on engineering and other projects, coupled with the urge for speed. It takes time to make a map. When a project has been approved, it is assumed that engineers can immediately put their plans into operation; in fact, they try to do so, but in consequence much waste is no doubt incurred.

In the past, and probably to a certain extent at present, we have been working in the belief that our natural resources are inexhaustible. Even though realizing that some of the resources may become exhausted, many are of the opinion that "Yankee ingenuity" can find suitable substitutes. This economic philosophy may be applicable to a primitive community where the resources have been scarcely touched and where the population is very sparse.

Today, however, there are approximately 130,000,000 people in the United States. What the population will be fifty or a hundred years from now no one can predict with any degree of accuracy, but it surely will be greater than it is at present. In consequence, we should take stock of our inheritance and make plans to use what we have in a rational and not a wasteful way.

The resources referred to consist of soil; forests; waters in our rivers and streams; and minerals of all kinds, including natural gas, petroleum, and coal. Underground water is becoming one of the most valuable of all. We hear much of conservation of resources, but how can a plan be made for such conservation without an inventory of what we have? That inventory, in turn, cannot be made with any degree of success unless we have accurate maps on which to base the surveys of natural resources.

We have been making charts and maps in this country for more than a hundred years. The charts used in navigating along our coasts are in a very favorable condition. While much remains to be done in the way of charting, the urge for good charts on the part of the Navy and the commercial navigator has made it possible to secure funds in amounts sufficient to meet the most pressing needs of those sailing the seas.



PLANE TABLE AND ALIDADE USED BY U. S. COAST AND GEODETIC SURVEY, WITH TABLE CUT AWAY TO SHOW TRIPOD MOUNTING

Maps of the interior of the country, on the other hand, range from the most modern topographic map to the road maps handed out at filling stations and the diagrams in railroad folders. A map of course should meet the needs of the map user. In some cases the user wants only a bare outline of certain features such as roads, streams, and bridges. In other cases he may desire only areas for plotting census data, or he may require the most minute details of the terrain for the planning and laying out of engineering works.

After years of mapping, only a small percentage of the country's area is covered by high-grade topographic maps. Topographic maps have been made of 47 per cent of the area, but it is estimated that not more than half of the maps are of sufficient accuracy or are sufficiently up to date to meet the needs of exacting map users. Much of the early topographic mapping was of a reconnaissance type. Funds were scarce and the urge to show the general character of the terrain was great; therefore topographic engineers covered large areas at small unit costs and in short periods of time.

Such maps probably met the needs of the map-using public at the time, but today map users are engaged in very much more costly works. In the building of bridges, dams, power plants, and highways, and in the extension of pipe, telephone, telegraph, and power lines over the country, distances must be known with accuracy; otherwise either the company financing the operations or the construction company may get into financial difficulties. Adequate maps also make it possible to select the best location for such structures.

The speed at which topographic maps should be produced is a matter that will depend entirely upon the need for them. Certain areas should have been mapped long ago and others perhaps may remain unmapped for a decade or longer without greatly inconveniencing our people. Priority should be given those areas where the demands are the greatest and the most urgent. The mapping can be pushed with great rapidity or it may be planned to extend over a large number of years. Personally, I think that at least three-quarters of the unmapped and inadequately mapped areas should be covered by topographic maps of modern type within the next ten years; and the remaining 25 per cent should be mapped within the succeeding five years.

One may believe that when a map is made it is good for all time to come, but this is a mistake. As highways are extended, rivers improved, and villages and towns expanded, the map gets out of date. Natural features such as forests and swamps change their form quite frequently. But the revision of a map in order to bring it up to date is a very simple matter, provided the original map was well made. When the map is first made, roads, streams, houses, and even fence lines should be placed on it in their true geographic positions. The contouring should be accurate within the scale of the map and the needs of the map users. If this basic information is properly shown, then by means of airplane pictures we can add new features to a new edition and erase from it those features that no longer exist.

UNDERGROUND STATION MARK ESTABLISHED AT CANNONBALL HOUSE, MODEL FARMS, PHILADELPHIA, IN 1879

In Recovering This Mark in 1926 the Crock Was Broken and a New Mark Set

FEDERAL AND NON-FEDERAL SURVEYS

While we hear much today about government competition with private business, I believe that the work on a national mapping plan should be done by the federal government because there are no recognized agencies of a private nature that are equipped to make the control surveys and to do the topographic work for a large mapping program. Furthermore, even if such a company were organized and should purchase equipment for the job, it might find itself at the end of its first contract outbid by some other company, and in this event would have on its hands much expensive material, constituting a distinct loss. The government, on the other hand, can plan for one or more of its branches to do the mapping, and should there be a change in the agencies, the equipment purchased by one can easily be transferred without loss to another.

While any engineer can learn to do high-grade surveying and mapping, yet there are few engineers in private practice who have the opportunity of engaging in this work to the extent necessary to become experts, either in planning and organizing or in carrying out the technical operations. On the other hand, in the government service there are persons who have devoted their lives to solving surveying and mapping problems. They carry on in an efficient way and secure results of the required degree of accuracy at a minimum cost in time and money. Even states are scarcely justified in setting up mapping organizations, since their equipment would not be needed after a few years and would represent a loss.

The mapping of a metropolitan area, on the other hand, is of such a specialized nature that the work should be undertaken only by the engineering department of the city government. Such maps require frequent revision as the area develops, and surveying and mapping parties would probably be called upon for almost constant field duty in order to place new features on successive issues of the map.

Since the general public is benefited by accurate maps, should it not pay for carrying out a national mapping plan? It is far easier to have one organization handle this highly technical problem than to have many of them attempt to do so. State boundaries should not be considered in planning for and carrying on the work, and it would seem futile to try to coordinate the efforts of the governments of the 48 states and the federal government. In the last analysis, a map made in any one state which may lead to increased production or add to the welfare of citizens living in the mapped area, will be directly or indirectly beneficial to the people in other parts of the country. The cost of mapping anywhere, except in metropolitan areas, may thus fairly be paid from funds that go into the federal treasury through the tax route.

There is one exception to this general statement however. Special maps of great detail and extreme accuracy may be required by a county or by a state for a restricted area within its borders. In such a case, the extra cost of making such a map should be borne by the state or county. For the normal mapping of the area, on the other hand, government funds should be used, supplemented by contributions from the state or county.

SURVEY METHODS

Until recently, practically all surveying and mapping was conducted by ground methods. Today, in many lines of surveying and mapping we are using pictures of the ground taken from airplanes. These airplane pictures show data that might be missed if ground methods only were used. It is most probable that the use of aerial photography in surveying and mapping will greatly increase. Of course we cannot depend entirely upon airplane pictures for mapping. In order to make the map complete, the data secured from airplane photographs can be supplemented by use of the plane table, which is the ideal ground instrument.

Aerial photography is of particular value in making so-called plane or planimetric maps. Many purposes can be served by a map that is accurate in area, scale, position, distance, and direction, but which does not show elevations and slopes. It is generally recognized that, owing to the time required to make a contoured map, it would be well to cover an area with airplane pictures and have planimetric maps made from them. Then, as the map users require contouring and elevations for certain parts of the area, the contours can be drawn in. This contouring in many instances can be done by means of machines which use overlapping aerial photographs. The so-called stereoscopic method will indicate to the map maker the configuration of the ground. In other cases, especially in areas that are only gently rolling, the contouring must be done by ground methods, preferably with the plane table.

There are certain areas for which controlled mosaics, made simply by fitting together the airplane pictures, will give all the information that is needed at the time. These should be considered as reconnaissance maps as they are only the first step towards getting a knowledge of an area. They can be prepared very quickly and cheaply and are especially valuable where work must be undertaken on short notice. Controlled mosaics have been made and used by the Soil Conservation Service of the Department of Agriculture when the officials in that Service could not wait for a modern topographic map to be made. No doubt planimetric maps will also be made from the aerial photographs taken for the controlled mosaics.

One of the debatable questions before the map maker, and also the map user, is the scale or scales on which the maps should be made. One class of users may

wish a very small scale in order that a large area can be shown on a single sheet. Others may want the most minute data of the terrain indicated, and in this case the map would be of very large scale with only a small area represented on each sheet. Then there are those who wish an intermediate type of map, on a scale that is somewhere between the very large and the very small ones.

In nearly all well-mapped countries, maps of the same areas are issued on different scales—large, small, and intermediate—and this, it seems to me, is desirable. If we are to have maps on different scales, then the original map must be on a scale that is comparable with the largest one on which the map will be published. It does not require a great deal more money and time to make the original map on a fairly large scale. Most of the United States, I believe, should be mapped on scales of from 1:15,000 to 1:30,000. Then from these original maps, printed maps on different scales can be secured.

THE NATIONAL CONTROL SURVEYS

To be accurate, a map must be based upon control surveys. Control surveys consist of triangulation and leveling by means of which positions, distances, directions, and elevations are obtained. Already in this country considerable progress has been made in the so-called fundamental control surveys. A fundamental survey is one that furnishes a framework to which detailed control surveys can be fitted. The plan being followed in the United States is to have arcs of first-order triangulation and lines of first-order leveling spaced at intervals of approximately one hundred miles. These arcs and lines form great nets with meshes approximately one hundred miles across. Triangulation and leveling are based upon datums.

The triangulation datum is defined by the position of Meades Ranch, a station in central Kansas, whose latitude and longitude were derived from an analysis of the connected arcs of triangulation and the many astronomical determinations of latitude, longitude, and azimuth made at triangulation stations throughout the country. All triangulation is computed from that one station. An adjustment of the arcs of triangulation in their general outline has been made, and the stations of any new arcs adjusted to that net will have final geographic positions.

The datum for the leveling net is mean sea level as determined at a number of tidal stations on the Atlantic, Gulf, and Pacific coasts. While the level net indicates that mean sea level is not really a strictly level or equipotential surface, yet the deviations from such a surface are so small that the mean sea level at each of the fundamental tide stations is held as zero in the adjustment of the leveling net.

Within the meshes of the first-order triangulation and leveling nets there are many miles of arcs of triangulation and lines of levels of second order. The first-order accuracy is very high, the average closing error of a triangle being about 1 sec, with a maximum allowable closing error of 3 sec. In leveling, a first-order line is run in both directions with precision instruments. The closing errors of loops in first-order leveling are small, the correction per kilometer seldom being greater than 0.2 mm.

In second-order triangulation, the average closing error of a triangle must be not greater than 3 sec, with a maximum closing error of 5 sec. As a matter of fact, on practically all the second-order arcs the average closing error is somewhat less than 2 sec. On second-order leveling the lines are run with precision instruments and precise methods, but in only one direction unless it fails to close the loop within the prescribed limit. In such case the line is re-run in order to detect the mistake or to overcome the accumulation of errors.

In the United States there are now 68,000 miles of first- and second-order triangulation, and 261,000 miles of first- and second-order leveling. Much of this work was done during the past four years with emergency funds appropriated by Congress for the relief of unemployment. The work was carried on by the U. S. Coast and Geodetic Survey until August 1935, when the allotted funds became exhausted. No other emergency funds have been allotted to the bureau, and since the normal appropriations are very small, little work has been done on the control surveys since that date.

While the field work is well advanced, there remains a large amount of computing and adjusting of the field observations to be done. In cooperation with WPA agencies, computing offices have been established in New York, N.Y., New Haven, Conn., Atlanta, Ga., Little Rock, Ark., Oklahoma City, Okla., and Gainesville, Fla., where appreciable progress is being made towards processing the results of the accumulated field work. The information secured in the field is of little value until completion of the office work necessary to establish the final geographic positions and elevations of stations.

All triangulation and leveling stations are substantially monumented. The monument usually consists of an inscribed bronze tablet set in a large boulder, in an outcrop of solid rock, or in a block of concrete. At all modern triangulation stations a second monument is placed at a distance of approximately a quarter of a mile from the station, and its azimuth or direction from the station is determined. This makes it easy to use a triangulation station as the starting point for a local traverse. The second monument is placed in such a position that it can be observed by the instrumentman from the ground at the station, avoiding the necessity for a target at the second monument.

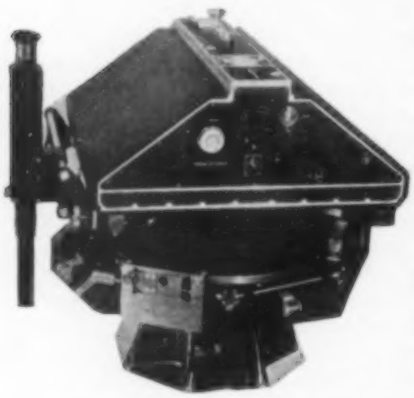
As rapidly as practicable, the control-survey data are published in pamphlets that are sold by the Superintendent of Documents at nominal figures. Copies of the preliminary data may be secured, at the small cost of blue-printing or photostating, by communicating with the Director of the Coast and Geodetic Survey, Washington, D.C.

Triangulation Station Onini, Island of Molokai, Hawaii

Showing Permanent Observing Platform withD emountable Pole and Target Signal

The fundamental arcs of first- and second-order triangulation and lines of first- and second-

order leveling are spaced at 25-mile intervals. With such spacing very few places will be more than 12 or 13 miles from a monumented station whose position and elevation have been determined. Such spacing, however, is too wide for the use of topographic engineers and of engineers engaged in surveying and mapping local projects, and eventually additional triangulation or traverse stations must be established for horizontal control, and additional lines of levels for elevations. Just what the spacing should be is a matter that will have to be determined as the surveying and mapping of the country progress.



NINE-LENS AERIAL CAMERA USED BY U. S. COAST AND GEODETIC SURVEY

One Photograph with This Instrument Will Cover as Much Area as 20 Single-Lens Cameras

This supplementary control should be of a high grade, but whether of second- or third-order accuracy is a matter of opinion. It is my belief that second-order work can be carried on at almost the same cost as third-order. The advantage of second-order work is that the results secured would meet the most exacting demands of the users of control-survey data.

USES OF CONTROL-SURVEY DATA

There are many uses for control-survey data other than as bases for topographic maps. They are valuable for all kinds of work around metropolitan areas, including the mapping and alignment of streets and roads, the survey of public utility lines, and the planning and building of underground structures such as conduits and subways. They are particularly valuable in planning for bridges. Outside metropolitan areas, the control-survey data will be used by engineers in the planning and construction of highways, pipe lines, flood control, irrigation projects, hydroelectric power projects, and other developments involving the use of water.

One of the most important uses of the control-survey data would be in the establishment of boundary lines of states, counties, cities, forests, parks, rights of way, and farms. While in the West we have a land system with the area laid out in squares approximately a mile on a side, in most of the eastern states the property-line surveys are in a rather uncertain condition. Most of the latter lines were laid down in Colonial times or shortly after the Revolution by means of the Gunter's chain and compass. No regular geometric pattern was followed in laying out farms. The dividing line between two estates was, in general, some easy route of travel. If there were swamps, heavy timber, or water courses, the line would meander along a route which would avoid these features in order to reduce the cost of the boundary survey. With land plentiful and cheap, the surveying had to be correspondingly low in cost. But now times have changed. With increase in population, land, relatively speaking, is getting scarce and is of greater value. Cadastral surveys, involving the boundaries of private and public land, will undoubtedly be carried on very much more extensively in the future than in the past. Many engineers could and should be absorbed in this very important line of work. The day has passed when an untrained man can make a map or survey that will be acceptable to the users.

In addition to the agencies of the federal government which are engaged primarily in surveying and mapping, there are other federal agencies which make special surveys incident to their regular work; these should be stimulated to carry on their work with such accuracy that the results may supplement the national surveying and mapping and be useful to others. It is also to be hoped that state, county, and city agencies making surveys and maps, as well as private individuals and corporations, will do their work in such a way that the results may be of value and use to others.

All survey stations should be substantially monumented, no matter who establishes them. When no substantial monuments are set, the survey is of no value for future work. Only the records of observations and computations are usually left, and nothing tangible is to be found on the ground, with which future surveys could be correlated.

If all the detailed surveys executed by other than the federal map-making agencies—consisting of lines of levels, triangulation, and traverse—could be fitted into the national survey nets and the national map, a real contribution would be made to the capital account of the country and the welfare of its citizens.

PLANE COORDINATE SYSTEMS

Most engineers are unwilling to make computations of their horizontal-control surveys on the spherical-coordinate system, which involves the determination of latitudes and longitudes. The computations are rather involved and require much time. In order to overcome this difficulty, the Coast and Geodetic Survey has devised a plane-coordinate system for each of the various states.

In making computations of horizontal-control surveys, a strip of the earth's surface 158 miles in width may be treated as a plane surface without introducing errors greater than 1 part in 10,000; this amounts to 6 in. per mile. Because of the narrow widths of some states, their surveys and maps require but a single strip or zone; other states require systems consisting of two or more zones. The dividing line between two zones in a state system follows county boundaries, all of any one county being included within a single zone.

Instructions and tables have been issued by the Coast and Geodetic Survey which will enable any one to use a state plane-coordinate system. Of course the work is not absolutely simple, but any engineer can learn the system in a few hours and can then make the computations involved. By means of a plane-coordinate system, the engineer can start from one horizontal-control station, say one of an arc of triangulation, and connect with some other station at a distance of 5, 10, or more miles away, and be able to compute by the familiar method of latitudes and departures the plane coordinates of the turning points of his traverse. After the computation has been made, the line can be easily fitted in between the two fundamental control stations by distributing the closing error.

Many calls have been made on the Coast and Geodetic Survey for the plane coordinates of its triangulation stations and for the pamphlets that describe the state systems. It is reasonably certain that this use of the triangulation data will greatly increase.

The Menai Suspension Bridge

And Other Bridges Designed and Constructed by Thomas Telford in His Later Years

By JOHN F. BAKER, ASSOC. M. AM. SOC. C.E.

and JOHN ARMITAGE

RESPECTIVELY PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF BRISTOL, BRISTOL, ENGLAND AND EDITOR, "SQUASH RACKETS AND FIVES," LONDON

FOREMOST among Telford's bridge-building achievements, the suspension span connecting Anglesey and the mainland of Wales across the Menai Straits was technically and esthetically unique at the time of its completion in 1826. Telford's success in this connection may be attributed in part to his experimental research in the strength of wrought-iron subjected to transverse loads and to his strict enforcement of material specifications. But the ingenuity which enabled him first to conceive and then to carry out unprecedented designs not only for the Menai Bridge but also for the Conway Bridge cannot be overemphasized. Other evidences of this ingenuity may be found in the plan to use suspension cables built up of small wires for the proposed Runcorn bridge and suspended centering for the proposed arched bridge over the Menai Straits. These and other interesting phases of Telford's later years are presented herewith in an abstract of the last of a group of four lectures on Telford's life and works given by Professor Baker at the University of Bristol. The preceding articles appeared in "Civil Engineering" for November and December 1936, and for February 1937, respectively.

BEGUN in 1819, the suspension bridge constructed by Thomas Telford across the Menai Straits, from Carnarvon, Wales, to Anglesey, formed the most important link in the Shrewsbury-Holyhead road, described in a previous article. The location of the bridge and road are shown in Fig. 1. While not the earliest suspension structure, the Menai Bridge is one of the most beautiful ever erected. It is also noteworthy that at the time of construction this bridge was more than 100 ft longer in span than any other.

Telford first became interested in the suspension principle in 1814, when he recommended a wrought-iron suspension bridge for a crossing over the Mersey River at Runcorn. Although that structure was never erected, the work he expended on its design and the experimental research he then conducted, led him to recommend a similar type of bridge over the Menai Straits. It must not be supposed, however, that Telford was the originator of this type of structure. As early as 1741 a suspension bridge had been erected over the river Tees, and between that year and 1826 at least twenty-three were built in various parts of the world.

The first step in erecting the Menai Bridge was to build the towers. At the point chosen on the Straits, the breadth of the estuary at high water was 920 ft and at low water 480 ft. The towers were placed 580 ft apart, that on the Anglesey side being built on a rock called Ynys-y-moch, which is about 300 ft from the shore and rises 6 ft above the high-water mark. On the Carnarvon, or mainland, side it was necessary to excavate to a depth of 6 ft below low water before reaching satisfactory rock. The overall height of the towers above high water is 153 ft; and the roadway has a clearance of 100 ft above high water. The towers which are of hard, gray limestone, are hollow, with outer walls about 17 ft thick at high-water level and interior cross walls approximately 6 ft thick. Thus, during construction, four square apertures with sides 9 ft long could be seen in plan.

PLASTER STATUETTE OF THOMAS TELFORD, DESIGNED BY JOHN FLAXMAN, R. A.

Reproduced by Courtesy of the Trustees of the Lady Lever Collection, Port Sunlight, Cheshire, England

Just above the level of the roadway two openings were left, through which the carriageways of the bridge were to pass. These openings, which were 9 ft wide and 15 ft high, were divided by a wall 6 ft thick. Thence to the top, the tower was built solid. From the shores to the towers the roadway was carried on arches 52 ft 6 in. in span, four on the Anglesey side and three on the Carnarvon side, supported on piers 65 ft high. The limestone for towers, piers, and arches was found at Penmon on the northeast coast of the island, and was brought to the site of the work in small sailing boats.

The masonry work was finished in June 1824. Before the great task of placing the suspension chains could be started, it was necessary of course to provide anchorages. This was no easy task. It was accomplished by driving three inclined shafts, each 6 ft in diameter, side by side at each end of the bridge. Those on the Anglesey side had to be carried nearly 210 ft and to a depth of 60 ft, and those on the Carnarvon shore

BRIDGE OVER THE RIVER CONWAY, WALES, BUILT BY THOMAS TELFORD IN 1826
Extra Cables Were Added Above the Four Original Chains Twenty-Five Years Ago

to a length of about 240 ft and a depth of 70 ft before a stable rock foundation was found. The ends of the three tunnels were then joined by a transverse gallery cut through the rock, and a cast-iron frame was built up against the inner wall of the gallery. The chains were attached to this frame by means of wrought-iron bolts 6 in. in diameter, passing through holes drilled in the ends of the chains.

The roadway, 28 ft in width, was to consist of two carriageways, each 12 ft wide, separated by a center footpath 4 ft wide. The chain system, consisting of four groups of chains, was arranged so that two of the groups hung over the outside edges of the road, and the other two hung 2 ft on either side of the center line. Each group consisted of four chains, 15 in. apart vertically, each individual chain being made up of five wrought-iron links set side by side. Each link was 1 in. thick and $3^1/_4$ in. deep. A cross-section of the whole chain system therefore contained eighty links with a total cross-sectional area of 260 sq in. The majority of the links were 10 ft long. At the ends, their depth increased to $7^1/_4$ in. to permit the drilling of a 3-in. hole. Bolts passing through these holes connected the five links to one another and to the adjacent set in the length of chain.

The best Shropshire iron was used for these chains, and Telford appointed a representative to inspect every process in the manufacture. From his extensive experimental work, Telford believed that this wrought-iron would carry a load of 27 tons per sq in. before it fractured, but he also knew that at about half that load the yield point of the material would be reached. He decided, therefore, that no link should be called upon to carry more than 35 tons, or about 11 tons per sq in. A testing machine was constructed and each link was tested to that load before it was accepted for the bridge. After being cleaned and painted with linseed oil, the links were then transported from Shrewsbury to the Straits.

When the masonry of the main towers and of the approach arches had been completed, a temporary inclined timber support was constructed from the entrance of the anchorage tunnels to the tops of the towers. The lowest links in the first chain were then attached to the cast-iron frames in the anchorage galleries on each side of the river. As the links were added, the chains were carried through the tunnels and up the inclined ways to the tower tops. On the Carnarvon side additional links were added until the chain hung down to high-water level.

To connect the ends of the chains on either side of the Straits, Telford built a large raft, 450 ft long and 6 ft wide, and on it laid the length of chain needed to complete the span. Just before high tide the raft was floated into position between the towers, and one end of the chain resting on it was attached to the end of the chain hanging from the tower on the Carnarvon side. Capstans had been placed on the Anglesey shore, and ropes had been run from them over blocks on the top of the Anglesey tower down to the raft, where they were attached to the free end of the chain. The capstans were manned, and in one hour and 35 minutes the chain was raised to the top of the tower. Here it was fastened to the other end of the chain. The remaining fifteen chains were connected in the same way, and on July 9, 1825, the last was safely in position. An entertaining eye-witness has recorded how, after the first chain had been placed in position, three workmen had the temerity to pass along its upper surface. This performance involved balancing on a path only 9 in. wide, starting 153 ft above the water and stretching nearly 600 ft, with a dip at the center of 43 ft.

With the main chains safely in place, it was a comparatively easy task to hang the roadway from them. Vertical iron hangers, 1 sq in. in cross-section, were suspended from each of the four groups of chains at every 5 ft of their lengths. To the lower ends of each group of four suspended rods transverse beams were attached. Two layers of fir planking—the lower 3 in. and the upper 2 in. thick—were laid longitudinally on the floor beams, to which they were bolted, and a third layer of planking was nailed across them in a transverse direction. Continuous oak curbs were placed along the edges of the roadway to keep vehicles from damaging the hangers. Later, in 1825, side rails were added to the bridge, and toll houses and approaches were built.

On January 30, 1826, the structure was opened. Six and one-half years had been required to build it, and at that time the undertaking was plainly colossal. The span, which had a dip of 43 ft in the center, measured 570 ft, and the height of the roadway above high-water level was exactly 100 ft. The project required 2,200 tons of iron. No visitor to Menai will deny the beauty of the structure, while its efficiency can be gaged from the fact that after more than a century it is still in use.

BUILDING THE CONWAY BRIDGE

At Conway, near Menai, there stands another of Telford's suspension bridges, forming an additional

link in the same roadway system. Although a safer and shorter route from London to Holyhead had been provided by the road through Shrewsbury, the older road through Chester and Conway could not be allowed to fall into disrepair, as it served the rapidly expanding north with an outlet for its industry. However, travel on this road was delayed by the necessity for taking a ferry across the mouth of the Conway River. Telford decided to build a suspension bridge opposite an ancient castle which had stood at the mouth of the river since the days of Edward I. To quote from Telford's own account, "In the elevation of the supporting towers of the toll-house, gateway, breast-walls and parapets, attention has been paid to the castellated style, so that the bridge, which is right opposite to the water-entrance of the castle, has the appearance of a huge drawbridge, with an embanked approach or causeway."

Although there were difficulties to be overcome at Conway, they were not of the same order as those experienced at Menai. About 300 ft from the western side of the river there was a rocky island. It was proposed to span the distance to this island with a suspension bridge, and to construct an embankment from the island to the eastern side. Since the road adjacent to the river was at no great height, the main piers were built to a height of only about 40 ft.

The suspension span was 327 ft with a dip of $22^1/_2$ ft; the roadway, $17^1/_2$ ft wide, was only 15 ft above high-water level. The links and other details of the chains, the method of anchoring, and the suspension system were exactly the same as those employed at Menai. In the Conway Bridge, however, there were only eight chains, in two groups of four each. The cross-sectional area of the whole chain system was therefore just half that of the Menai Bridge, or 130 sq in.

Difficulty was encountered in placing the chains as the current was found too strong to allow the raft used at Menai to be moored. It was accordingly necessary to employ another method. The twelve ropes used for hoisting at Menai were stretched from the top of one tower to that of the other, and on them a temporary timber platform was built. The chain was put together on this platform and connected to the end pieces at the tops of the towers. The platform and ropes were then removed, and the hangers and roadway erected in the same way as at Menai.

Lack of space makes it impossible to do more than mention many of the undertakings completed by Telford during his later years. He was responsible for the Birmingham and Liverpool Junction and other canals; for improvements in the harbors of Aberdeen, Dundee, and Dover; for a ferry over the river Tay at Dundee; for St. Katharine's Dock, London; for alterations on the old bridge at Glasgow; and for the construction of numerous bridges, including those at Glasgow and Edinburgh, one at Pathead near Edinburgh, the cast-iron arch bridge at Tewkesbury, and the elliptical masonry arch at Gloucester. He carried out numerous surveys for roads in South Wales, between London and Liverpool, and between London and Edinburgh. In many cases, however, the information he provided and the advice he gave had not been acted upon at the time of his death. Two undertakings, which Telford planned but did not carry out, are of special interest. The first of these was the design of a bridge to cross the Mersey at Runcorn, in which Telford incorporated some developments of the suspension bridge which were not considered practicable until the middle of the nineteenth century.

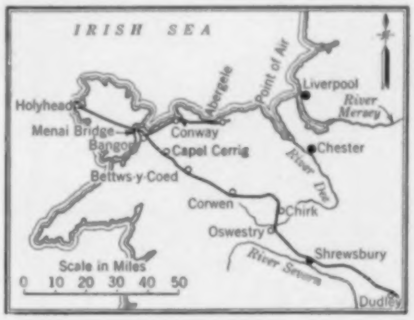


Fig. 1. Location of the Menai and Conway Bridges with Reference to the Holyhead-Shrewsbury Road

Bridge Proposed at Runcorn

Runcorn lies some 20 miles up the Mersey, where the river narrows to less than 1,500 ft. Telford was asked if he would consider a bridge to be practicable at this point, and, if so, what type he would favor. On inspection he found that the proposed site was in many respects favorable for a bridge, the chief advantage being that on the Cheshire side the bank was steep and composed of rock, while on the Lancashire side a flat rocky shore extended down to the low-water mark. Below low-water level, however, conditions were very different, since the channel, here about 1,000 ft wide, was a mass of sand and mud extending

General View of the Menai Suspension Bridge

The Suspended Span Is 580 Ft Long with a Clearance of 100 Ft Above High Water. Recently the Ministry of Transport Has Decided to Rebuild the Bridge, to Enable It to Cope with Modern Traffic Conditions While Still Retaining Its Original Form

to a great depth. The building of a pier in the channel was thus practically ruled out. Another factor involved in the situation was the height of ships passing above Runcorn, which required that the bridge should have a 1,000-ft span, and its roadway a height of not less than 60 ft above high water. Since the banks of the river were not sufficiently steep to make a high crossing economical, an arched bridge would have required a considerable rise to provide the necessary clearance. In addition, the necessity for providing centering might well have meant the closing of the river to traffic for a considerable time. And so, after considering all these factors, Telford suggested the erection of a suspension bridge.

VIEW THROUGH THE WEST TOWER, MENAI BRIDGE
Openings for Carriageways Are 9 Ft Wide and 15 Ft High

This proposal was made in 1814, four years before the Menai Bridge was considered. The latter was actually a result of Telford's research work at Runcorn on the strength of stretched wires carrying transverse loads, about which there was little or no information available. He wished to determine the magnitude of the load which might safely be suspended from a wire of malleable iron stretched between two points at the same level but a considerable distance apart. First, he tested many pieces of iron of varying thicknesses, determining the direct forces necessary to pull them apart lengthwise. Then he concentrated upon two classes of specimens—a number of bars with cross-sectional areas ranging from $3^1/_3$ to $^9/_{16}$ sq in., and twenty-one lengths of wire $^1/_8$ in. in diameter. The bars were tested in a hydraulic press in London. On an average, the pieces in this class broke under a load of 29 tons per sq in. The wire of the second class gave higher results, the average breaking load being 35.9 tons per sq in. From these and other results Telford concluded that a bar of good English malleable iron would yield at 15 to 16 tons per sq in. and break at 27 to 30 tons per sq in.

To discover the transverse load which could be suspended from a stretched wire, Telford had two vertical posts erected 100 ft apart. One end of a wire having a diameter of approximately $^1/_{12}$ in. was attached firmly to the top of one post. The wire was then carried over the top of the second post, and a weight was hung from the free end. Afterwards, additional weights were hung at three points, 25 ft apart, on the taut wire. Among many other tests, Telford dropped loads onto the middle of the stretched wire, in order to measure its resistance to impact. Apart from showing the safe load which a wire could carry, the experiments convinced Telford that it was practicable to build up a suspension cable with wires of small dimensions. With this knowledge he proceeded with the detailed plans for the Runcorn bridge.

It was calculated that the total load on the main 1,000-ft span would be 700 tons, including the weight of the hangers and an allowance of 100 tons for vehicles and passengers. Although experiments had shown that each square inch of cable could safely carry 5 tons, Telford decided to apply no more than four. To provide the necessary cross-sectional area, he decided to use sixteen cables, with an area of approximately 11 sq in. each. In each cable there were to be thirty-six wires, $^1/_4$ sq in. in area. It was planned to embed them in a mixture of beeswax and resin, thus making the whole mass impervious to water. To prevent the wires from separating, they were to be surrounded and compressed by four iron segments with a cross-sectional area of $1^3/_4$ sq in., stretching the whole length of the cable. In addition, all joints in the rods and segments were to be welded.

The proposed design for this cable is very similar to that in use today, the principal difference consisting in modern improved methods of guarding against corrosion. Although the bridge over the Runcorn was never erected, it is interesting to note that in 1814 Telford was advocating a method of cable construction which was not adopted for more than thirty years, but which thereafter held the field for eighty years almost unchallenged.

A DESIGN FOR SUSPENDED CENTERING

It may be of interest to mention an even earlier scheme devised by Telford in 1811 for providing suspended centering for the construction of an arch bridge over the Menai Straits. It was his intention to erect on the masonry abutments (which would eventually support the finished arch) substantial frames 50 ft high, to which the chains for the suspension of the centering would be attached. The centering itself was to be of timber, made up in four ribs. The first 50-ft length was to be built out from the abutment as a cantilever. As an added precaution, when the cantilever was in position its free end was to be attached by a chain to the frame on the abutment. After this length had been planked over, the second 50-ft section was to be assembled; run out, probably on iron rails, to the end of the platform; and swung into position by chains from the abutment frame and bolted to the first length. Telford surmised that this second length would be strong enough to stand alone, but a suspending chain was to be provided for additional support. In this way a continuous timber arch was eventually to be built, on which the iron castings for the permanent

arch could very easily be connected together. Although this device was never used, it marks a high point in Telford's ingenious solutions of unusual problems. As a matter of fact, it is a short step from this suggestion made in 1811, to the method of erection used for the great arch of the Sydney Bridge in 1930.

Perhaps one of the most ambitious undertakings with which Telford was ever connected was the proposed ship canal to connect the Bristol Channel with the English Channel, from the river Parrot near Bridgewater in the north, to Seaton on the south coast of Devonshire. An early plan for this canal was revived in 1811, when Rennie surveyed the ground, but nothing further was done until 1824, when a company was formed to build it. Telford was employed by this company to resurvey the ground and to suggest any improvements on Rennie's plan which might occur to him. The prospects of success for such a canal were good at that time, as about 300 miles of rocky and dangerous coast would be saved for vessels passing from the Bristol Channel to London.

It was planned that the canal should be 15 ft deep and 95 ft wide at the top, with locks 125 ft long, 30 ft wide, and with a rise of 8 ft. These dimensions are somewhat less than those of the Caledonian Canal, but the actual length of the trench to be cut would have been much greater ($44^1/_2$ miles). The terminal harbors were to be at Beer Cove, near Seaton, on the south coast; and at Stolford, near Bridgewater, on the north. At both places it would have been necessary to build piers of considerable length, bringing the cost of the scheme to an estimated total of £1,700,000. This sum was not forthcoming and the canal was never built.

First President of the Institution of Civil Engineers

The work which is likely to be the most enduring monument to Telford was not built of stone or iron. In 1818, a number of young engineers, many of whom had received their early training under Telford, formed a society for the advancement of engineering knowledge. In 1820 they decided to invite Telford to become their first president, and he accepted the invitation gladly. In March of that year he was installed in office. This new interest came at a very appropriate time in his life. Although only 63, he had decided to undertake no new construction projects but to devote himself entirely to the completion of those already under way. Being unable to alter his life-long habit of hard work, he threw himself wholeheartedly into the activities of the Institution.

The personality of Telford was such that the memory of it has not now been forgotten. He ruled with an uprightness to which the words of his inaugural address bear witness. "I have carefully perused the rules and orders," he said, "which have been prepared with much attention and I think they are now sufficiently matured to be a guide and guard for the conduct and welfare of the Institution.... It becomes incumbent on each individual member to feel that the very existence and prosperity of the Institution depends in no small degree on his personal conduct and exertions; and the merely mentioning the circumstance will, I am convinced, be sufficient to command the best efforts of the present and future members, always keeping in mind that talents and respectability are preferable to numbers...."

In 1828, largely as a result of Telford's exertions, a Royal Charter of Incorporation was obtained, in which the objectives of the Institution were stated. Telford formed the nucleus of a reference library with a collection of books still prized by the Institution. He made an unbreakable rule that the discussions which took place at the weekly meetings of the Institution should be recorded, and they now form a notable inventory of engineering progress. The Telford premiums and gold medals are still awarded each year to the authors of original contributions describing engineering works or advances in engineering science.

View of Approach to Suspended Span, Menai Bridge
Each Section of the Chains Is Made up of Five 1-In. by $3^1/_4$-In. Wrought-Iron Links

Telford did not adhere strictly to his decision not to undertake any fresh engineering works after 1820. The bridge at Tewkesbury was not started until 1823, and that at Gloucester was begun in 1826. Many of his road surveys were made after 1820, while the southern division of the road from London to Edinburgh was not started until 1825. At least two canal schemes were considered in this late period, although neither was constructed. Further, Telford served on the commission appointed to inquire into the state of the water supply in the metropolis, the report being submitted in 1828.

In 1827, when he was 70, Telford fell ill for the first time in his life. He recovered, only to experience relapses in 1832 and 1833. As soon as he could move he was once again traveling about the country wherever his business called him. In 1834 he inspected the Conway suspension bridge, and in the same year he received a request from the Duke of Wellington to advise him on the clearing of shingle from the harbor mouth at Dover. Telford went to Dover, inspected the harbor, and drew up plans for a brick tunnel 30 ft wide and 16 ft high, which was to discharge water through sluices onto an apron in front of the pier head. Contracts were called for, and the work started. Telford stayed to superintend it, but once again was stricken. He died September 2, 1834, in his 78th year.

Movement of Boulder Dam Due to Grouting

Measuring Block Deflections Resulting from Pressure Filling of Contraction Joints

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BOULDER DAM consists of a large number of slender columns with vertical joints grouted under pressure to form a monolithic structure. The methods and equipment used in the grouting work were described by James B. Hays in the February number of "Civil Engineering." In the accompanying article, Mr. Simonds tells how measurements were made of the block deflections caused by grouting the vertical joints, and notes the precautions taken to check excessive movements. Deflection curves, plotted by the author directly from gage readings, should prove helpful in guiding the work of grouting arched dam structures elsewhere. A description of the cooling system used to dissipate the heat liberated by the setting up of the concrete is also included. The article constitutes the fifth and last of a group of papers on grouting work at Boulder Dam. The first appeared in September 1936.

An arch dam is not an absolutely rigid structure. Since the concrete of which it is made possesses considerable elasticity and the foundation and abutments yield slightly when under load, the structure moves continually, although the movement is small. The application and removal of the water load on the dam, accompanied by seasonal variations in temperature, water-soaking of the upstream face, and deformation of the foundation and abutments, are the chief sources of the movements which occur in a completed arch.

Where a dam is built in blocks with contraction joints spaced at intervals of 20 to 75 ft, it is necessary to grout these joints in order to make it a monolithic structure. While blocks of a dam are designed for stability under reservoir pressure, they may not be stable under a high grout or water pressure in the contraction joints, and it is possible to cause, by the application of such pressures, greater deflections and stresses than those due to the reservoir load or the seasonal variation.

Moreover, with efficient grout pumps and modern systems for grouting, it is not at all difficult to apply a force of considerable magnitude to the blocks by merely building up the pressure in the joints. Excessive pressure may shear the blocks of a dam along the foundation joint or along some construction joint. If joints are grouted singly, excessive pressure will open the joint being grouted, and will bend over the adjacent blocks, thereby closing the joints on the opposite sides of the deflected blocks. Closing of the ungrouted joints adjacent to a joint being grouted was observed at Gibson and Owyhee dams. If the joints are radial in direction, the opening of a group of joints will be accompanied by deformation of the abutments or by an upstream deflection of the structure. Upstream radial deflections of the following magnitudes have been observed while grouting arch dams: At Gibson Dam, 0.176 in.; at Deadwood Dam, 0.063 in.; at Cat Creek Dam, 0.312 in.; at Owyhee Dam, 0.590 in.

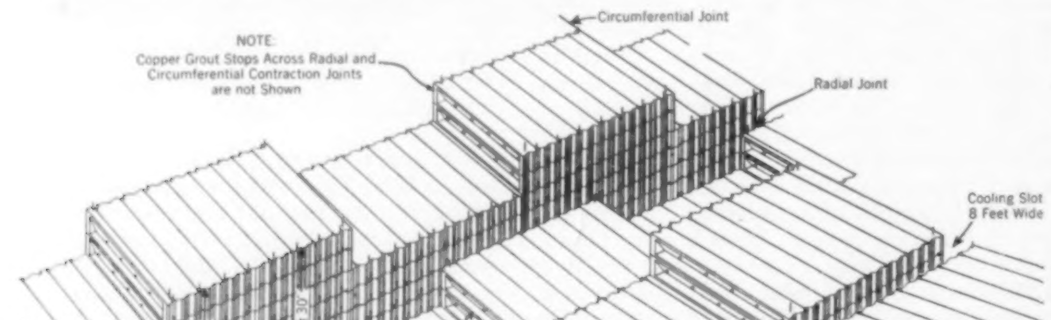


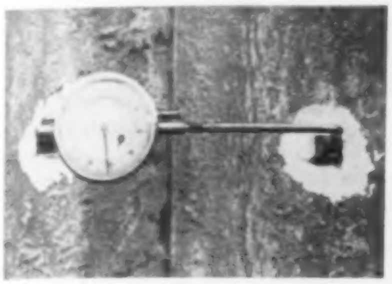
Fig. 1. Diagram of Blocks in Boulder Dam, Showing Arrangement of Cooling Pipes

Correct Grouting Pressure an Individual Problem

Laboratory experiments made by the U. S. Bureau of Reclamation have shown that satisfactory films of grout can be obtained by using pressures of from 50 to 100 lb per

sq in. on the grout in the joint. Pressures of this magnitude may be excessive for grouting joints in a dam built of small blocks. The problem of grouting the joints of an arch dam therefore varies with each structure, being dependent upon the size of the blocks, the height of the lifts between horizontal grout stops, and the spreading of the joints while under grout pressure.

Boulder Dam was built in blocks varying from 50 by 60 ft at the upstream face, to 20 by 30 ft at the downstream face. The blocks were wedge-shaped so as to conform with the voussoirs of an arch, and were keyed together in both radial and horizontal directions as shown in Fig. 1. A schematic layout of the cooling system and the arrangement and spacing of the pipes in the dam are shown in Fig. 2. Grout systems were installed for both the radial and circumferential joints so that each system of joints could be grouted independently in vertical lifts of 50 ft. As these blocks were fairly flexible, excessive pressure in any joint would easily spring that joint open and bend the blocks over so that the adjacent joints would close. In order to guard against undue damage to the structure while grouting, it was found advisable to mount dial gages across the joint openings and to watch the movement of the joint while the pressure was being applied. The rapid opening of a joint to a width greater than 0.02 in. in a vertical height of 50 ft is undesirable in a dam composed of blocks the size of those constructed at Boulder Dam.



Dial Gage Mounted Across Contraction Joint for Measuring Deflections

As a result of the experimental cooling of mass concrete in Owyhee Dam, Boulder Dam was equipped with a cooling system to dissipate the setting heat of the concrete, since it was most essential that the dam reach its minimum temperature before the joints were grouted. A slot 8 ft wide was left in the center of the dam during construction, and the manifolds attaching the cooling pipes to the supply mains were laid in this slot, as is shown in Fig. 1. As soon as the lower blocks of the dam had been cooled to the desired temperature, the manifolds were removed from the cooling system, and the system was filled with grout. Concrete was then poured in the slot.

In order to avoid excessive springing of the blocks adjacent to the slot, no joints were grouted until concrete had been placed in the slot to a height of 50 ft above the section to be grouted. It was therefore necessary to grout the dam in several different periods, depending on the rate of construction. The first period was from May 24 to June 14, 1934, when the joints were grouted from the foundation to El. 625. The second period was from July 25 to August 25, 1934, when all joints were grouted from El. 625 to 725. It was planned to grout thereafter two 50-ft sections of the dam during each grouting period. Accordingly, the joints were grouted from El. 725 to 825 during the third period, November 4 to 27, 1934; and from El. 825 to 925 during the fourth period, January 28 to February 16, 1935. At this time it was discovered that the temperature of the dam was increasing more rapidly than desired after cooling had been terminated in the completed section. In order to avoid this, each section was grouted immediately after concrete had been placed in the slot to a height of 50 ft above the section. This procedure was followed during the fifth grouting period, March 12 to June 7, 1935, when the joints of the dam were grouted from El. 925 to the top of the dam.

Upstream Face of Dam, Showing Grout Outlet Headers Piped to Handle Cooling Water Leaking into Joints

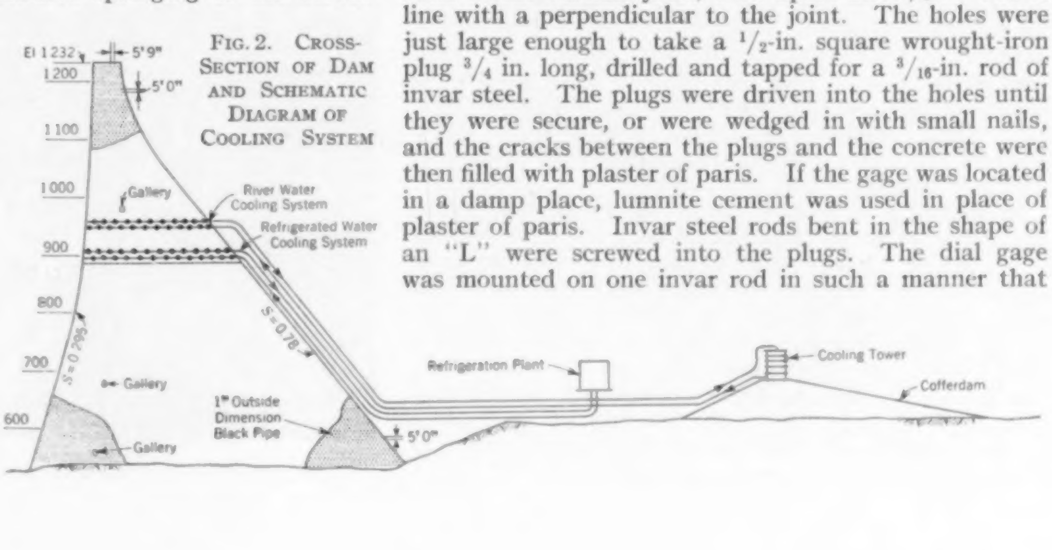
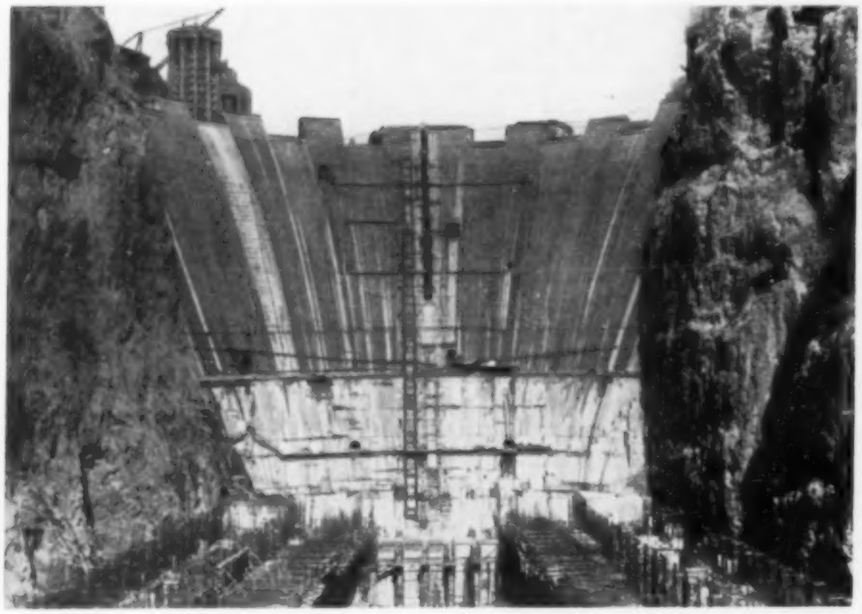


Fig. 2. Cross-Section of Dam and Schematic Diagram of Cooling System

MEASURING JOINT CHANGES DUE TO GROUTING

During the grouting of contraction joints of a dam, two types of deflection measurements are usually made—measurements showing the change in width of the joints due to grout pressure, and the radial deflection of the structure at the crown cantilever section. In the case of Boulder Dam, the latter type of measurement was not possible owing to the fact that grouting operations were started before the upper part of the dam was completed. Measurements showing the change in width of joints were made on all radial joints and on accessible circumferential joints.

The apparatus used in measuring deflections of joints consisted of dial gages equipped with jeweled bearings and measuring to 0.0001 in. In mounting the gages, square holes were drilled into the concrete on opposite sides of the vertical joint, 6 in. apart and $^3/_4$ in. out of line with a perpendicular to the joint. The holes were just large enough to take a $^1/_2$-in. square wrought-iron plug $^3/_4$ in. long, drilled and tapped for a $^3/_{16}$-in. rod of invar steel. The plugs were driven into the holes until they were secure, or were wedged in with small nails, and the cracks between the plugs and the concrete were then filled with plaster of paris. If the gage was located in a damp place, lumnite cement was used in place of plaster of paris. Invar steel rods bent in the shape of an "L" were screwed into the plugs. The dial gage was mounted on one invar rod in such a manner that



CONSTRUCTION VIEW OF BOULDER DAM, SHOWING 8-FT SLOT USED FOR COOLING HEADERS

it would bear against the end of the other rod, and set so that it would register any movement of the joint either in opening or closing. A gage mounted across a joint ready for measuring deflection movement is shown in one of the photographs. This type of gage is very satisfactory as it has sufficient range of movement and is reasonably accurate. Moreover, an enclosed type of gage is desirable as the gages are frequently sprayed by water or grout when leaks occur.

Measurements of spreading or closing of the joints can be made wherever a joint is accessible. Usually the measurements are made in the galleries or at the faces of the dam. If grouting is done during construction, while the gages are mounted on the faces of the dam, there is the hazard that they will be wrecked by falling rocks or timber. Consequently it is necessary to provide suitable shelters for them. If mounted in the galleries, the gages are in a safer position and are less subject to temperature change.

The general procedure followed in grouting Boulder Dam was to grout the radial joints first and then the circumferential joints. At lower elevations, where the joints were long, vertical grout stops divided the joints into two sections. These sections could be grouted separately or together as desired. A pipe line was laid from the mixer to the grouting galleries, and the supply headers of a group of joints were tied into it. A batch of thin grout was usually pumped into each joint at the start. This was followed by grout having a water-cement ratio of 0.7 by volume until all joints were full. Then pressure was applied to each joint. After pressure had been held on the joint for 15 to 30 min, grouting operations were terminated.

In grouting a section consisting of several radial joints, the adjacent radial joints were filled with water and held under low pressure to prevent them from being closed by the pressure of the grout. In filling the joints with grout, usually no material spreading occurred until the joint was full and pressure applied, except when the joints were close to the abutments. The abutments deformed quite readily while the radial joints were being grouted. The deformation was greater on the Arizona side than on the Nevada side because of the character of the abutment rock.

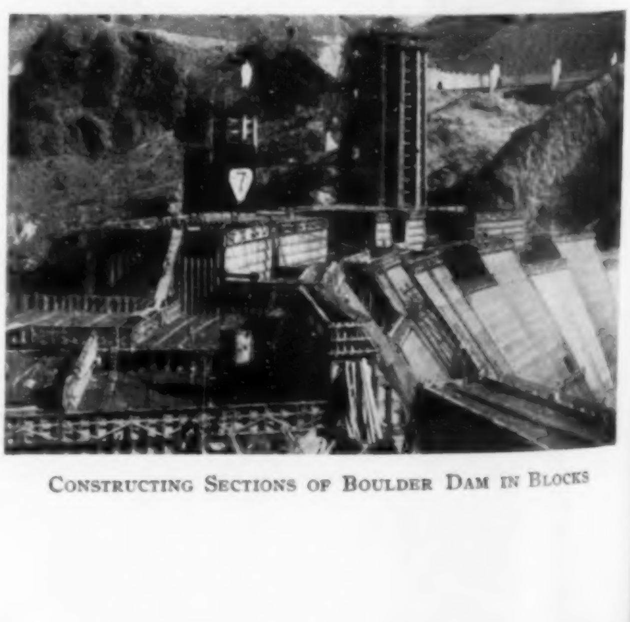
When pressure was applied to a radial joint, the gage was watched. As soon as the joint opened approximately 0.02 in., the supply valve was closed, thereby holding the joint under pressure, and the pressure from the pump was applied to another joint. This process was repeated until all joints in the section being grouted were holding pressures at their outlet headers at the faces of the dam.

Measurements of joint movement were made not only at the top and bottom of each 50-ft lift being grouted, but also at points 50 ft below the bottom of the lift and 50 and 100 ft above the top of the lift. The largest deflections usually occurred at the top of the lift being grouted, although at times the deflection at the bottom had considerable magnitude. No spreading of the joint was observed 50 ft below the section being grouted. Some movement of the joint was observed 50 ft above the top of the lift being grouted, but 100 ft above the top of the lift no movement of any consequence occurred.

When the joints had been grouted to the top of the dam, the deflections measured at each lift were added and deflection curves obtained for the entire height of the joint. A typical deflection curve, indicating the movement of Joint *HI*, is shown in Fig. 3(*a*). Two deflection curves are plotted in this figure. The maximum deflection indicates the greatest spreading of the joint while the grout was in a fluid condition under pressure from the pump. As the grout set, an adjustment took place, and the final deflection was obtained from observations made after the grout had set. These observations were made between 4 and 8 hours after the grouting was completed.

The joints usually opened while under pressure. During the adjustment period when the grout was setting, the joints would close slightly in most cases. Occasionally some joints would close beyond their initial position, owing to an unbalancing of the pressures as the grout settled in the joints. This occurred in Joint *HI* at El. 1,025 and 1,175 [Fig. 3(*a*)].

The final deflection of the radial joints is shown in Fig. 3(*b*). The deflection on the Arizona side of the dam was somewhat larger than on the Nevada side, chiefly owing to the influence of the abutment. The



CONSTRUCTING SECTIONS OF BOULDER DAM IN BLOCKS

spreading in Joints EF and GH was rather large, and forced Joint FG to close between El. 825 and 975. Joint FG closed above El. 1,025, chiefly because of the spreading of Joints BC, CD, and DE. The spreading of the two center Joints IJ and KL was remarkably uniform and consistent. These joints were the largest in the dam and were not influenced by the abutments. The deflections of the joints in the upper third of the dam were small, owing to the fact that lower pressures were used in grouting the joints in this region than in the lower part of the dam.

JOINT MOVEMENT DIFFICULT TO CONTROL

In grouting a group of several joints at one time, it is not possible to control the spreading of each joint exactly. Quite often when the same pressure is applied to a group of joints, one joint will close while the others open. At times one joint might open considerably more than the others of the group while under the same pressure. While an attempt was made to limit the maximum spreading to about 0.02 in., some joints occasionally opened a larger amount. The maximum spreading observed while grouting was 0.0533 in. This occurred at Joint GH, El. 725, while grouting the 675–725 lift. The final deflection at this location after the grout

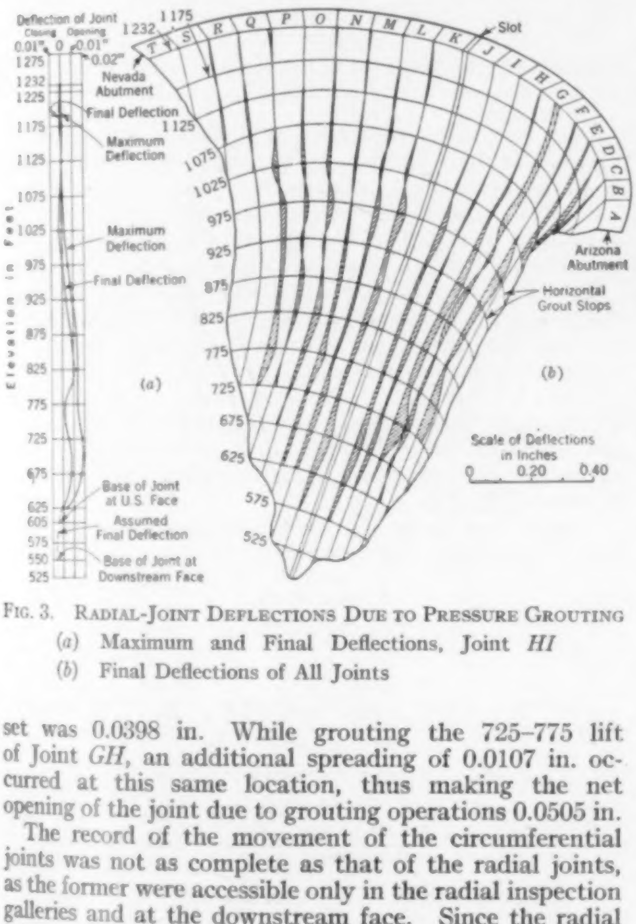
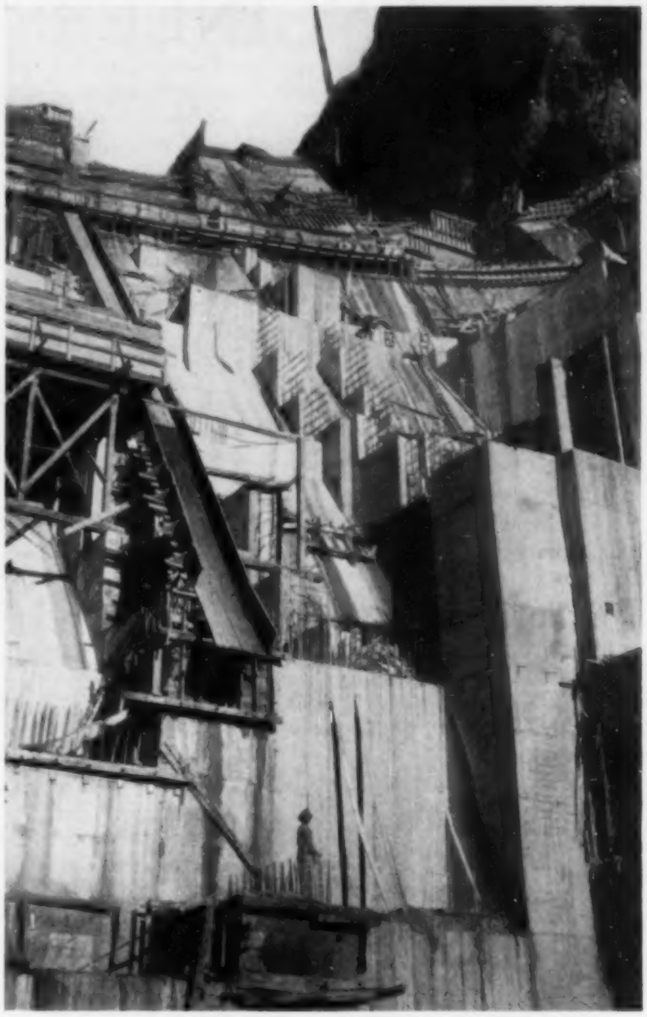


FIG. 3. RADIAL-JOINT DEFLECTIONS DUE TO PRESSURE GROUTING
(a) Maximum and Final Deflections, Joint HI
(b) Final Deflections of All Joints

set was 0.0398 in. While grouting the 725–775 lift of Joint GH, an additional spreading of 0.0107 in. occurred at this same location, thus making the net opening of the joint due to grouting operations 0.0505 in.

The record of the movement of the circumferential joints was not as complete as that of the radial joints, as the former were accessible only in the radial inspection galleries and at the downstream face. Since the radial joints of each lift had been grouted from abutment to abutment before the circumferential joints, the blocks of the dam were fairly well restrained, and the spreading of the circumferential joints was therefore much smaller than that of the radial joints.

The supply headers entered the circumferential system at Joint 4–5. This joint opened wider than the subsequent joints as the grout found its way to the outlet headers at the faces of the dam. The decrease



THE BLOCKS WERE DEFLECTED BY GROUTING CONTRACTION JOINTS

in the width of joint opening of the subsequent joints was fairly uniform in the upper elevations of the dam. In the entrance gallery to the Nevada side of the power house, some irregularities were encountered. Joint 7–8 opened almost as much as Joint 4–5 while under pressure. A leak developed at Joint 4–5, and as it was necessary to remove the gage to caulk the leak, the final reading was lost. The deflection of Joints 4–5 and 7–8 formed about 90 per cent of the total spreading of the circumferential joints in the M-row at that elevation.

The deflection measured at each joint shows the joint movement while grouting. It does not indicate the thickness of the film of grout nor does it show the size of the opening between the blocks of the dam at the time of grouting. The thickness of the grout film can only be determined by drilling a core across the joint. Some exploration of the joints of Boulder Dam by core drilling indicated films of good-quality grout in the joints, ranging in thickness from $^1/_{64}$ to $^3/_8$ in.

This work was performed under the direction of B. W. Steele, Assoc. M. Am. Soc. C.E., formerly designing engineer on dams, and Ivan E. Houk, M. Am. Soc. C.E., senior engineer of the Bureau of Reclamation, of which R. F. Walter, M. Am. Soc. C.E., is chief engineer, and John L. Savage, M. Am. Soc. C.E., is chief designing engineer. All activities of the Bureau are under the direction of John C. Page, M. Am. Soc. C.E., commissioner of reclamation, whose headquarters are at Washington, D.C.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Artificial Vibration—A New Method of Dynamic Research

By Rudolph K. Bernhard

Consulting Engineer, Philadelphia, Pa.

This is a short report of a new method of dynamic research in the engineering field, abstracted from a more complete, unpublished paper by Dr. Bernhard.

ARTIFICIAL vibration consists essentially of inducing vibrations in the structure to be tested, by means of an oscillator attached directly to it, and observing the energy consumed by the oscillator at various frequencies of vibration. All the dynamic properties of a structure can be determined by this method, including fatigue, endurance limit, damping ductility (or crackless plasticity),* damping capacity (or its reciprocal, the amplifying factor), period of resonance, and effect of time or aging on fatigue specimens. The method can be used on any size or type of structure from small laboratory specimens to bridges or battleships. It can be applied to a complete structure, to any of its component parts, or to a model. It can be used on any kind of structural material. Since 1928 a considerable number of tests have been made by this method on subjects varying widely in size and type.

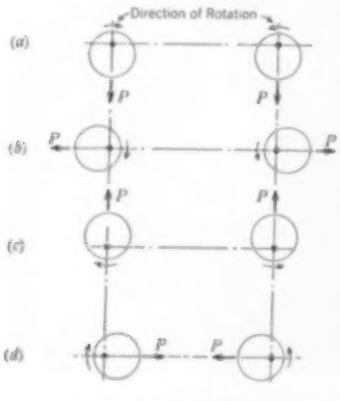


Fig. 1. Principle of Oscillator

At *a* and *c*, the forces of the two masses are vertical and additive; at *b* and *d* they are horizontal and, being in opposite directions, cancel each other

The oscillator itself is a simple and compact machine. It consists of two equal masses, eccentrically supported, and arranged to rotate in opposite directions. This rotation sets up alternating forces (Fig. 1), which can be represented by a sine curve whose amplitude depends on the size of the masses, their eccentricity, and the speed of rotation. The latter factor can be regulated as desired.

The oscillator may be driven by an electric motor. It can be built to operate at frequencies between 1 and 100 cycles per second, and is available in various sizes to produce centrifugal forces varying from 0.001 ton to 20 tons. Since in running a test, the force exerted by the oscillator is magnified by the vibration of the structure itself, particularly if the frequency is near the resonance period, pulsating forces of great magnitude can be set up. This magnification may be as much as 40 times for a bridge structure. Therefore, using a 20-ton oscillator on such a bridge, the oscillating force would be 800 tons. In order to select an oscillator of the proper size to set up the desired forces in a structure, the magnification factor for that structure must be known from previous tests or must be computed.

Fig. 2. Arrangement of Equipment for Bending and Direct Stress Tests

a, specimen; *b*, oscillator; *c*, tachometer; *d*, wattmeter; *e*, battery or generator; *f*, resistance; *g*, deflectometer

In general, a test is carried on in the following manner. The oscillator is fastened to the structure in such a way as to produce the type of stress desired. The set-ups for testing a beam in bending, and a bar in direct stress are shown in Fig. 2. The supports for the test structure must be designed so as to avoid energy loss.

The frequency of the oscillator is varied in steps, starting with a low frequency and continuing to well beyond the period of resonance (natural frequency). For each frequency the energy input for the oscillator is measured by means of the wattmeter. Similar energy input readings are taken for the same frequencies for the oscillator running free—that is, carrying no load and exciting no vibration. These readings are plotted as shown in Fig. 3.

The highest point, *E*, on the frequency-energy input curve is the period of resonance. The frequency at this point is designated by n_0. Point *G* bisects *EF*. Line *AGB* is drawn so that $AC = GF = BD$. The frequencies at *A* and *B* are designated by n_1 and n_2, respectively. Then the following formulas hold true (for derivation see "Dynamic Method of Investigating Stresses in Buildings," by the author, in *Der Stahlbau*, No. 6, 1929, and Dr. W. Spaeth's *Theory and Application of Oscillators*, Springer, Berlin, 1934):

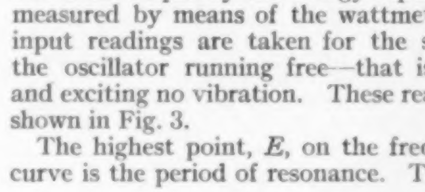


Fig. 3. Manner of Plotting Test Data

1. Resonance period $= n_0$
2. Damping angle $= \tan\varphi = \dfrac{n_2 - n_1}{n_0}$
3. Logarithmic decrement $= \delta = \pi \tan\varphi$
4. Dynamic amplifying factor $= \pi/\delta = \cot\varphi$

* See "Damping Capacity of Materials," by Dr. G. S. von Heydekamp, in *Proceedings of the American Society for Testing Materials*, Vol. 31, Part II, 1931; also "A New Property of Metals," by H. F. Moore, in *Iron Age* for September 10, 1931.

The analysis of results and their application in determining the strength of the structure is too complicated to be discussed thoroughly here, and will be mentioned but briefly. Knowing the amplifying factor and the physical properties of the oscillator, the force induced by the oscillator operating at any frequency can be computed. If it is desired to run a fatigue test, the test can be continued and the oscillator run at any desired frequency for the required number of cycles. If a frequency near the period of resonance is selected, the desired forces can be induced by a smaller oscillator than would otherwise be required, thus making for economy.

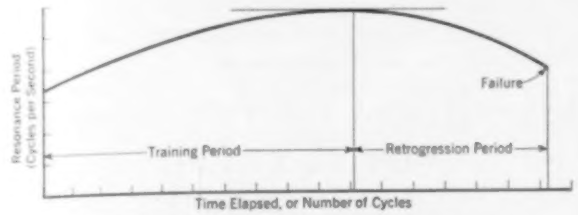


Fig. 4. Effect of Age on Resonance Period

The effect of time or the aging effect on a fatigue specimen is studied by measuring the resonance period from time to time during the fatigue test, and plotting the results as shown in Fig. 4. Completed structures which cannot be tested to failure can be inspected in a similar manner from time to time during their life. As long as the resonance frequency is increasing, the structure is in the training period, as indicated in Fig. 4, and is safe. As soon as the resonance frequency starts to decrease the structure is entering the retrogression period and approaching the failure point.

It is also possible to discover by artificial vibration the presence of anharmonic vibrations or non-quasistationary oscillations. Anharmonic vibrations are caused, if, with varying amplitudes, the dynamic qualities—that is, the elastic capacity, the damping values, or the oscillating masses—are changing likewise. Non-quasistationary waves are produced when the different parts of any oscillating system do not vibrate in phase.

Table I. Average Dynamic Properties of Various Vibrating Systems

Systems	Damping Angle in Degs	Tan φ	Logarithmic Decrement	Time to Build up Vibrations in Secs	Amplifying Factor
Bridges, engine parts, ceilings, walls, towers, ship decks, masts, airplanes, and airship parts . . .	5.7	0.1	0.31	7.3	10
Foundations, ballast, buildings, springs of vehicles, street surfaces, wires . .	11.3	0.2	0.62	3.7	5
Ships, certain soils, etc. . .	21.8	0.4	1.25	1.8	2.5

Table I summarizes some average values of dynamic properties for numerous systems investigated by artificial vibration.

In conclusion, several advantages of this new method of dynamic testing may be mentioned briefly:

1. Complete structures can be tested. This will result in a more complete analysis, including external conditions. Furthermore, as fatigue failures usually occur at points of change in cross-section, generally at connections, a test of the complete structure is highly desirable. It is also of great advantage in making studies for earthquake forces.

2. The method has an extremely wide range of application as to both size and type of structure (Table I). Moreover, tests can be reproduced as often as desired.

3. Almost all the dynamic qualities can be determined by this method independently of the force of gravity.

4. The necessary equipment is small and compact enough to be transported readily and is simple enough to be used under almost any conditions. The oscillators are not affected by temperature, weather, or other external conditions. Hence structures can be tested in the field.

5. The method is economical. An oscillator is less expensive than any standard fatigue testing machine of equal capacity, is foolproof and easily operated. The equipment does not require much storage space when not in use.

Capping Concrete Cylinders

By Edwin A. Grone

Department of Engineering Mechanics, University of Nebraska, Lincoln, Nebr.

The work of testing concrete cylinders, bricks, tiles, and similar specimens can be considerably accelerated by the use of cast-iron caps like those shown in the accompanying photograph. They were developed some years ago at the University of Nebraska, and have proved both satisfactory and economical.

These caps should be about $^1/_4$ in. larger in diameter than the cylinder to be tested. The thickness for a 6-in. cylinder, exclusive of the lugs, should be $1^1/_2$ in. If the caps are to be used for testing brick, the thickness should be at least $1^3/_4$ in. They will weigh about 13 and 16 lb each, respectively, for 6-in. cylinders. Both the face and the lugs should be finished. The three-point bearing allows a non-rocking contact with both the platform and the spherical head of the testing machine.

A mixture of 46 per cent by weight of dental plaster of paris to 54 per cent quick-setting cement is used as a capping material. This mixture is made up to a consistency corresponding to about a 2-in. slump, and an experienced operator can cap one end of from 16 to 20 cylinders with one batch of material before it sets.

To insure that the faces of the caps will be exactly perpendicular to the axes of the cylinders, a capping device like that shown in the picture should be used. The operator places a cap, face up, below each of the V-grooves, covers it with a quantity of capping material, and then slides a cylinder down the groove onto it. After allowing the capping material 10 or 15 minutes to

Preparing Concrete Cylinders for Testing

harden, he inverts the cylinders and repeats the operation. A wiped joint is made at each end between cylinder and cap.

In research work it is desirable to use a V-framework in the testing machine to center the cylinder under the spherical block. In routine testing, the cylinder can be set by eye. Small shims may be used under the lugs when necessary.

The cost of capping a group of twenty-five 6 by 12-in. cylinders, for the average experienced operator, is as follows:

7.5 lb dental plaster of paris @ \$0.021	\$0.158
8.9 lb quick-setting cement	0.256
Labor (capping): 40 min @ \$0.40 per hr	0.267
Total cost of capping 25 cylinders	\$0.681
Cost per cylinder.	0.027

The time required to test the cylinders will vary with the strength of the cylinders and the speed of the testing head. In a hydraulic testing machine, it should be possible to test 25 cylinders with a strength of from 3,000 to 4,000 lb per sq in., in about 70 minutes. With labor at 40 cents an hour, the cost per cylinder for testing would be \$0.019, making the total cost per cylinder \$0.046.

Measuring Curves by Means of Substitute Polygons

By DAVID B. HALL, ASSOC. M. AM. SOC. C.E.

ASSISTANT ENGINEER, STATE DEPARTMENT OF PUBLIC WORKS, ALBANY, N.Y.

WHEN the length of a curve is obtained by measuring along a series of chords, it is necessary to use fairly short steps to obtain a high degree of accuracy. If, however, the measurement is made along a series of secants selected as shown in Fig. 1(a), an astonishingly high degree of accuracy can be secured with much longer intervals. For example, the chord measured across a 90-deg circular arc is about 11.1 per cent short, but the secant chosen in the manner indicated is only 0.23 per cent short.

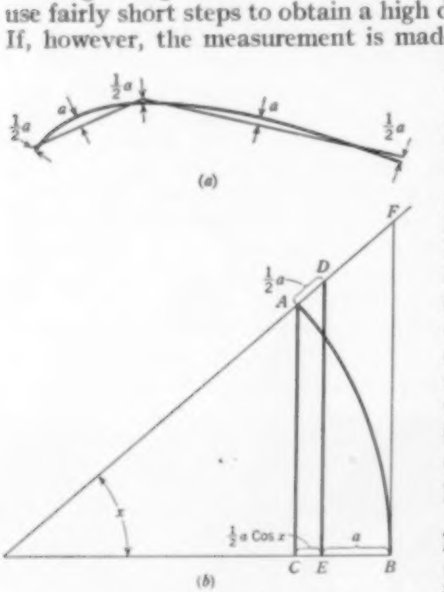


FIG. 1. ILLUSTRATING USE OF SECANT FOR MEASURING CURVES

The proof follows. In Fig. 1 (b), if the radius is unity, then the length of the arc $\widehat{AB}$ is x. The length of $\overline{AC}$, expressed as a polynominal series, is

$$\overline{AC} = \sin x = x - \frac{x^3}{6} + \frac{x^5}{120} - \frac{x^7}{5040} + \ldots\ldots [1]$$

Now $\dfrac{\overline{CE}}{\overline{CB}} = \dfrac{\overline{DE} - \overline{AC}}{\overline{FB} - \overline{AC}}$. Hence the length of $\overline{DE}$, lying between the sine and the tangent, is

$$\overline{DE} = \sin x\left(\frac{a}{a + \frac{1}{2}a\cos x}\right) + \tan x\left(\frac{\frac{1}{2}a\cos x}{a + \frac{1}{2}a\cos x}\right) = \frac{3\sin x}{2 + \cos x}.$$

This may be expanded to give

$$\overline{DE} = x - \frac{x^5}{180} - \frac{x^7}{1512} - \ldots\ldots\ldots [2]$$

In either Eq. 1 or Eq. 2, the difference in length between the arc $\widehat{AB}$ ($= x$) and the straight line ($\overline{AC}$ or $\overline{DE}$) is given by the second and subsequent terms of the series. Hence $\overline{DE}$ is clearly a far closer approximation than $\overline{AC}$.

Decorative Concrete Obtained by Accident

By HAROLD F. FAVRET

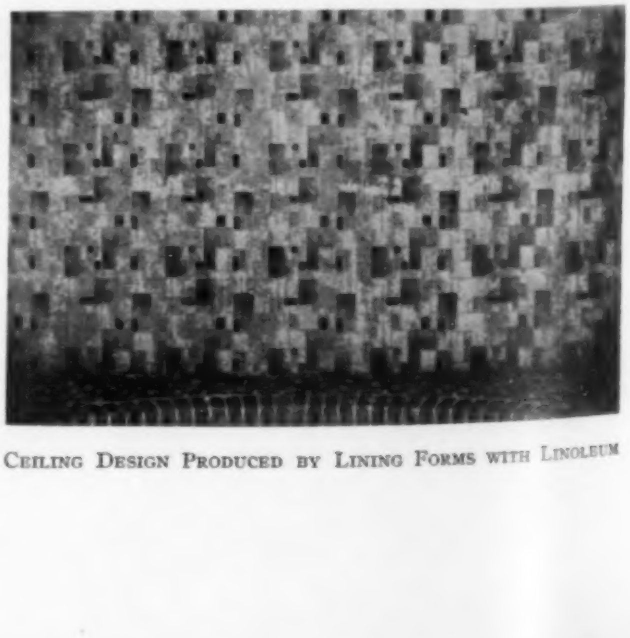
SEC'Y, TULANE UNIVERSITY STUDENT CHAPTER, NEW ORLEANS, LA.

A CONTRACTOR in New Orleans has accidentally hit upon an inexpensive method for producing decorative concrete walls and ceilings that deserves further investigation. The possible results, as viewed from below, are indicated in the accompanying picture.

To obtain a smooth finished concrete, it had been his practice to line his forms with wallboard. This was satisfactory, but rather costly, and on a recent contract he decided to replace the wallboard lining with linoleum. When the forms were removed, it was found that the design of the linoleum had become imprinted in the concrete. The coloration is not merely on the surface, but has penetrated to a slight depth.

It seems likely that the cause of this transfer was the heat generated by the concrete in setting. It may of course be questioned how long the color will remain, but it would seem that for ceilings and other surfaces that are not subjected to wear and abrasion, it should last indefinitely. The picture shown here was taken about two months after the slab was poured, and it can be seen that the colors had not faded.

The linoleum used was an ordinary, cheap variety. Its unit cost was approximately the same as that of the wallboard, but it required no treatment before using, and could be used more than once. (The same results were obtained when a piece was used the second time; the third time gave smooth finish but poor design.) Moreover, it was available in larger sizes than the wallboard, and therefore required less labor to place. The costs of labor for placing on one particular job were 12 and 10 cents per square foot for wallboard and linoleum, respectively.



CEILING DESIGN PRODUCED BY LINING FORMS WITH LINOLEUM

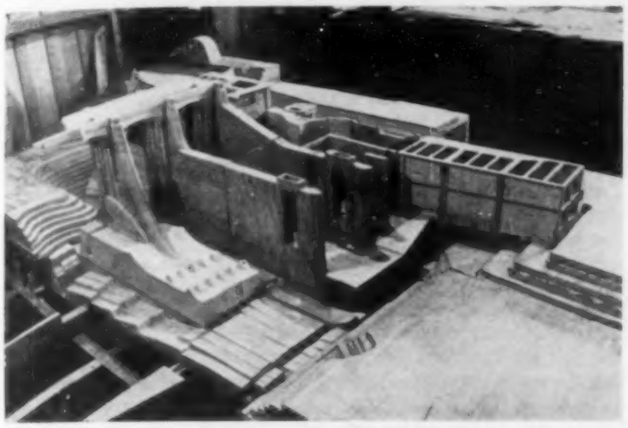
OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Models Valuable in Construction

Dear Sir: In the Bonneville development, described by C. I. Grimm and J. C. Stevens, Members Am. Soc. C.E., in the October issue, models for design features had their place, especially in the field of hydraulics. Readers of these articles may be interested in the accompanying view of Bonneville Dam, taken from the construction models of the Columbia Construction Company, contractors for the dam and fishways.

This and similar models were made for purposes of education and ably served that purpose by exhibiting the design features in the



Model of a Part of the Bonneville Dam, Looking Southeast
Built by the Columbia Construction Company, Contractors for the Dam and Fishways

solid, a much simpler method than that of long study and correlation of hundreds of drawings. The models, which are true to the scale of U. S. Engineer Department designs, served to clarify design problems and supplied facts needed in the construction policies program. They amply demonstrated their value in economy and efficiency, while at the same time affording a medium of contrast for the consideration of various construction plans.

This process of direct visual education of all concerned in the construction of works of importance is recommended to all design and construction engineers. Although in most engineering projects plans are available only to head-office staffs, models make this knowledge available to all. The informed workman is always more capable, and where all have a common grasp of purpose, the work proceeds with unusual ease to a successful conclusion.

David Donaldson
Engineer, Columbia Construction Company

Portland, Ore.
March 9, 1937

Financing Highway Construction

To the Editor: The articles by U. N. Arthur and Joseph White, Members Am. Soc. C.E., and Edward L. Schmidt, in the January issue, bear striking testimony to the need for a thoroughgoing revision of our methods of financing street and highway construction and maintenance. For such public expenditures, governmental units in the United States—national, state, county, and municipal—now depend, of course, on three main sources of funds: (1) General taxation, that is, property taxes, income and inheritance taxes, and other general sources of public revenues; (2) special taxation of motorists, such as gasoline taxes, state registration fees, and federal excise taxes; and (3) benefit assessments on land made more valuable by street or highway improvements.

Students of public finance accept both "benefits received" and "ability to pay" as proper bases of taxation. In general, I think it may be said that of these two bases the "benefits received" method is to be preferred in all cases where such benefits are approximately ascertainable and are reflected adequately in ability to pay. If this premise is accepted as sound, it follows that general taxation should be resorted to, for street and highway construction and maintenance costs, only to such extent as such costs cannot be recovered on an equitable basis from the users of public thoroughfares or from the land values which are produced or maintained by the building and upkeep of the streets and highways.

As the above-mentioned articles have made clear, it is becoming increasingly impossible to determine—especially in the case of major highways—the benefits which landowners derive from new or widened thoroughfares. In the case of an ordinary 50- or 60-ft street, rough justice may be done by assessing the entire cost of the original paving and sidewalks against the abutting property. But for major thoroughfares the problem is so complex that a land-value increment tax, based on actual results, may prove to be more equitable than special assessments based on anticipated results.

The increment-tax method of financing public improvements would have another important advantage. By means of the special assessment method the governmental unit can never collect more than the total cost of a particular improvement, even though the actual income in property values may be many times that amount. The increment tax, on the other hand, would be paid after the gain had been realized and when the profit was actually in hand, thus constituting no hardship to the owner. The taxpayer would not be penalized by having to pay more than the resulting increase in value, as may happen under the present plan, and the government would not be limited to receiving back only the cost of the improvement in cases where a very much greater increase in value results.

Another equitable method of financing municipal and county expenditures would be through the substitution of a general tax on land-values or ground rents for our present inequitable real estate tax. It is land values and not improvement values that are enhanced in the main by public expenditures. Pittsburgh, under its so-called graded tax plan, has gone a short distance in the direction suggested. There is need for a more comprehensive study than has yet been made of what has actually happened in Pittsburgh under the graded tax plan, and engineers and others should give thorough consideration to this whole problem of equity in the financing, not only of major highways but of public improvements.

Harold S. Buttenheim
Editor, "The American City"

New York, N.Y.
February 25, 1937

Some Early Engineering Predictions

Dear Sir: From time to time I have heard discussions as to who first suggested dividing highways by a white line to separate streams of traffic. In this connection I find that in 1883 an old friend of mine, Prof. John Macnie, of the University of North Dakota, wrote a book, in which he made the following prediction: "Railroad cars are of light and elegant construction, with individual seats for each passenger and are electrically propelled. The use of aluminum alloys permits lightness with great strength."

He also said that, "Horses are obsolete, except in zoological museums, and travel is over well-maintained highways in light, automotive vehicles, called curricles, which are capable of speeds as high as twenty-five miles per hour. Highways are divided in the center by a white line to keep each stream of traffic in its place. Near the larger cities they are divided into three lanes, with the heavier traffic relegated to the outer lanes."

More of this quotation is given in the December 1934 issue of the University of North Dakota *Alumni Review.*

Frank B. Walker, M. Am. Soc. C.E.
Chief Engineer, Eastern Massachusetts Street Railway

Boston, Mass.
March 8, 1937

Problems in Highway Design

TO THE EDITOR: I should like to comment on the article on "Important Considerations in Highway Design" by W. V. Buck, M. Am. Soc. C.E., in the January issue. It seems to me that we have not placed sufficient emphasis on the matter of sight distance on our highways. Driving on a highway that has short sight distances over the tops of the hills is like driving at night with poor headlights. Our highways should be designed for a minimum sight distance of 1,000 ft, and where practicable, this should be increased to 1,500 ft.

Whether we are ready to admit it or not, there is a definite trend towards classification of traffic on the highways. So far, it has not been possible to designate for the public certain roads which they must use because of the type of vehicle or the speed at which the vehicle is to be used. It is necessary now, as it may be for some time to come, to mix vehicles of all types. The four-lane highway with parking strip between the inside lanes is the nearest to a classification of traffic that has been made to date. This keeps the slow-moving traffic in the outside lanes and obtains at least a partial classification of traffic.

I believe that there is very little, if any, justification for three-lane highways. The whole theory of this type of highway is completely wrong, as the three-lane highway invites passing traffic into head-on collisions. On two-lane highways, the driver realizes when he is passing another vehicle that he is driving directly against the flow of traffic. However, this is not the case on three-lane highways, which lead the driver of the passing vehicle to believe that he has as much right to the center lane as anyone else.

It is suggested that it may be possible to partially divide the traffic on two-lane highways by blocking out a portion of the center of the pavement. This central portion of the pavement would have to be smooth enough to permit cars to cross it when they are passing other vehicles, but it could be constructed in such a manner that it would encourage vehicles to stay in their own lanes except when passing other cars.

In the case of right-of-way widths, I believe a minimum width of 120 ft is necessary for the proper construction of any important highway. In addition to this, it is very important that the highway be zoned for a distance of from 100 to 200 ft back on each side of the right of way, in order to prohibit the construction of filling stations, billboards, homes, or obstructions of any kind.

It should be noted that public sentiment against by-pass routes, even around smaller cities, is changing in favor of such routes. One of the predominant factors in this change of public opinion has been truck transportation. For instance, many cities and towns are demanding that by-pass routes be constructed for the transportation of gasoline, because of the fire hazard created by the possibility of a wreck.

The most difficult design problem confronting highway engineers is that of the reconstruction of existing highways. Too often there is the temptation to spend additional funds on existing highways that have bad alignment and hazardous grades. The more money we put into any highway improvement which is fundamentally wrong, the more money we are wasting, rather than saving. It is difficult for the public to realize that highways built twenty years ago are obsolete or inadequate, even though the pavement may still be in fairly good condition. The fact that we are not obtaining finances for the replacement of old pavements as rapidly as we should is responsible to a great extent for the hazards that lie in our highways today.

HUGH D. BARNES, Assoc. M. Am. Soc. C.E.
State Highway Engineer, Kansas State Highway Department

Topeka, Kans.
February 28, 1937

St. Lawrence Power Estimates

TO THE EDITOR: In the article in the December 1936 issue of CIVIL ENGINEERING, entitled "Are St. Lawrence Power Estimates Too High?" the late Theron M. Ripley, M. Am. Soc. C.E., arrived at the conclusion that the St. Lawrence power estimates are too high. This conclusion is not corroborated by a study of the subject made by the U. S. Lake Survey Office.

There is a close relationship between lake levels and rainfall. High lake levels are always associated with excess rainfall, and low levels with deficient rainfall. The level of the St. Lawrence River at Montreal reflects the almost continuous dredging below that point that has been in progress since 1860, and has no relation to either lake levels or rainfall. There was a general decline in lake levels between 1860 and 1935 caused by a deficiency in rainfall, as indicated by Mr. Ripley's Fig. 1. This decline has been affected by the Chicago diversion and by other artificial works.

A study of all available lake levels, some of which date back to 1810, and of weather records beginning in 1836, indicates that there were lower levels between 1810 and 1825 than have occurred since then. The rainfall gradually increased, and there were high levels and high rainfall generally in the period, 1850–1890. Then followed a general decline, and in 1934 Lake Ontario was lower than it had been since 1825. All the evidence indicates a long cycle of lake levels between 1810 and 1935, the first 15 years being the lowest, and the last 15 years almost as low. The projection of the decline for the last portion of the cycle, 1860 to 1935, forty years into the future, as was done by Mr. Ripley, is unjustified. As stated by Mr. Ripley, the lakes have been rising since 1934.

The years 1934–1935 represent a period of extreme deficiency in supply. The large deficiency in rainfall, particularly on the lower lakes, was supplemented by the effect of the cofferdams in the lower Detroit River and by unusually severe ice conditions in the St. Clair River. Water, which normally would have entered Lake Ontario, was stored in Lakes Michigan and Huron. The retardation of flow by the cofferdams was nearly 10,000 cu ft per sec.

As Mr. Ripley stated, there is no reference to primary power in the Report of the St. Lawrence Board. Plate 22, Appendix B of that report shows the duration of flow under regulation, based on the years 1861–1925. This curve shows 185,000 cu ft per sec as the flow which would have occurred 100 per cent of the time. This quantity might be assumed as the amount of water available for primary power. But Mr. Ripley adopted an estimate by T. H. Hogg of 210,000 cu ft per sec. The curve shows this flow occurring only 73 per cent of the time. The tables showing deficiency in flow presented by Mr. Ripley are not only based on an assumed quantity of primary water which is 25,000 cu ft per sec too large, but he failed to consider the effect of regulation as contemplated by the Board.

In the opinion of the U. S. Lake Survey Office the evidence indicates that the present condition in the Great Lakes region is merely a normal portion of a weather cycle which has covered over one hundred years, and there is no need for revision of the present St. Lawrence project.

C. R. PETTIS, M. Am. Soc. C.E.

Detroit, Mich.
February 26, 1937

New Jersey Geodetic Control Survey

TO THE EDITOR: In his article on "Development of State Grid Systems," in the January issue, O. S. Adams has described the brilliant contribution made by the U. S. Coast and Geodetic Survey to the progress of surveying methods in this country. With the introduction of state-wide systems of plane coordinates, the Survey has made available to the plane surveyor the vast net of geodetic control that covers the United States.

This means that sooner or later there will be but one survey in the entire United States. It means that a road survey can start from a triangulation point and tie up on a property corner, or can originate at a river survey marker and terminate at a tunnel triangulation point. The closure on these points will indicate the accuracy of the work, and adjustment to these points and monumenting the line will make it a permanent part of the control net. It will be possible to compute in the office, without one hour of field work, the exact measurements of all parcels of land to be acquired for right of way, or to compute the exact location of any county line the road may cross. Such a road traverse is ready for immediate use as control for an aerial map or as a basis for describing the boundaries of a neighboring farm.

Engineers are familiar with the advantages of a standard vertical datum. That is but one dimension. These coordinate systems introduce standard datum for two more dimensions. Not only do they correlate distance and direction, but they are everlasting, witnessed as they are by all other stations.

Since early in 1934 the state of New Jersey, through its Department of Conservation and Development, has sponsored an emergency project, known as the New Jersey Geodetic Control Survey, for the purpose of establishing control monuments along streets and highways by traverses tied to the fundamental triangulation net. This state has by law recognized its system of coordinates as a means of describing property. Essex County has based its new map on this system by running traverses from the control points of the New Jersey Geodetic Control Survey and plotting the map by the state coordinates. Hudson County is using the work for the control of highway traverses, and on every blueprint the state coordinates of the survey stations are shown. In Mercer County the Board of Freeholders has passed a resolution requiring all properties acquired for county roads to be described, where possible, by this new method. Camden, Gloucester, and Atlantic counties are establishing the county boundary line by means of this system, and cities are working out ordinances requiring the application of this method to the land description in new real-estate developments.

The state-wide riparian stream and waterway survey is establishing many traverses throughout the state. These traverses are monumented, tied to the control net, and computed by means of the coordinate system. The federal government is likewise using this method to describe the property for the Resettlement Administration projects in New Jersey. The Philadelphia District of the U. S. Engineer Department is using this system for surveys of the Absecon Inlet, tributaries to the Delaware River, and the Inland Waterway, and the Department of Institutions and Agencies is demanding control points on its property. Private enterprise is not far behind. Several large industrial organizations are already using this system. It is hard to estimate its use by private engineers, but requests for information are received daily from engineers throughout the state.

These survey systems have, in general, made available geodetic control and coordination by eliminating the extra expense usually entailed in training men for geodetic computation and in making such computation. A new era is dawning in this country—an era of unification, precision, and permanency of surveys, of the elimination of duplication, and of the rapid compilation of all surveys, maps, and plans.

Philip Kissam, Assoc. M. Am. Soc. C.E.
Associate Professor of Civil Engineering
Princeton University

Princeton, N.J.
February 27, 1937

Penetration Tests Being Made on Recovered Asphalt

To the Editor: In his interesting paper on the "Weathering of Asphalt Pavements," in the January issue, Malcom S. Douglas, Assoc. M. Am. Soc. C.E., has considered many phases of the problem. At the Ohio Highway Testing Laboratory in Columbus, we have attacked the problem of hardening of the asphalt in our hot-mixed, hot-laid, asphaltic concrete pavements. Our investigation, which is as yet preliminary in nature, has been concerned with the hardening of the asphalt during the preparation of the asphaltic concrete and with the hardening caused by aging in the pavement.

In this investigation only the hot-mixed, hot-laid, asphaltic concrete wearing-course mixtures, as specified by the Ohio State Highway Department, were used. These mixtures consist of from $6^1/_2$ to 10 per cent of asphalt having an original penetration of 50 to 60, from 30 to 50 per cent of sand, and from 45 to 60 per cent of coarse aggregate. Mixing takes place at temperatures from 275 to 375 deg.

In Fig. 1 (*a*) is shown the percentage of the original penetration of the asphalt recovered from samples taken from fifteen pavements, which had been in service up to four years and four months. As would be expected, the penetration drops as the age of the pavement increases. Unfortunately, we have as yet been unable to secure sufficient samples to indicate the ultimate tendency of this curve. The sample marked *D* is not indicative of the slope of the curve, as serious cracking was apparent in this pavement when it was only two years old. This sample shows a heterogeneous spot test as do most of the points which fall below the curve. The spot tests were run on the recovered asphalt only and not on the original material. The samples marked *A* are from different jobs, but the asphalt used was from the same refinery, indicating that the cracking of the asphalt on those samples marked with a double circle occurred either at the asphaltic concrete plant or after the material was in the road.

In Fig. 1 (*b*) is shown the percentage of original penetration of asphalt recovered from seventeen samples taken from test sections cut from pavements which had just been laid. This graph indicates that approximately 25 per cent of the original penetration of a 50 to 60-penetration asphalt is lost in placing the pavement on the road. It also indicates that asphalt from different refineries may harden more than others and that the same asphalt used in different asphaltic concrete plants may show a different penetration loss.

The percentage of original penetration of asphalt recovered from fourteen samples, taken directly from the mixers at six different asphaltic concrete plants, is shown in Fig. 1 (*c*). This graph indicates that both the time and temperature of mixing have a direct effect on the penetration of the asphalt used. The percentages of original penetration of the asphalt from the asphaltic concrete plant, No. 3, shown on this graph, are low for both 275 and 375 deg.

It is interesting to note on the graph shown in Fig. 1 (*b*) that the asphaltic concrete plant No. 8 is the plant just referred to [Fig. 1 (*c*)] and that it shows the lowest percentage of original penetration. It should also be noted that the same asphaltic concrete plant produced the material marked by the letter *D* in Fig. 1 (*a*). In each instance the asphalt used was produced by a different refinery, which indicated in this particular case that the fault lies rather with the asphaltic-concrete plant than with the asphalt producer.

I note Professor Douglas' report of cracks that appeared in the surface of a pavement as a result of the contraction of its Portland cement concrete base. The Ohio State Highway Department has laid a number of asphaltic concrete pavements on a 6-in. asphaltic concrete base course, laid in two 3-in. courses, both for widening of existing pavements before the placing of a new wearing course and for entirely new construction work. A number of these pavements have been in service for four or five years and, to date, have shown little or no signs of cracking.

Thomas W. Brannan, Jun. Am. Soc. C.E.
Assistant Engineer, Ohio State Highway Department Testing Laboratory

Columbus, Ohio
February 26, 1937

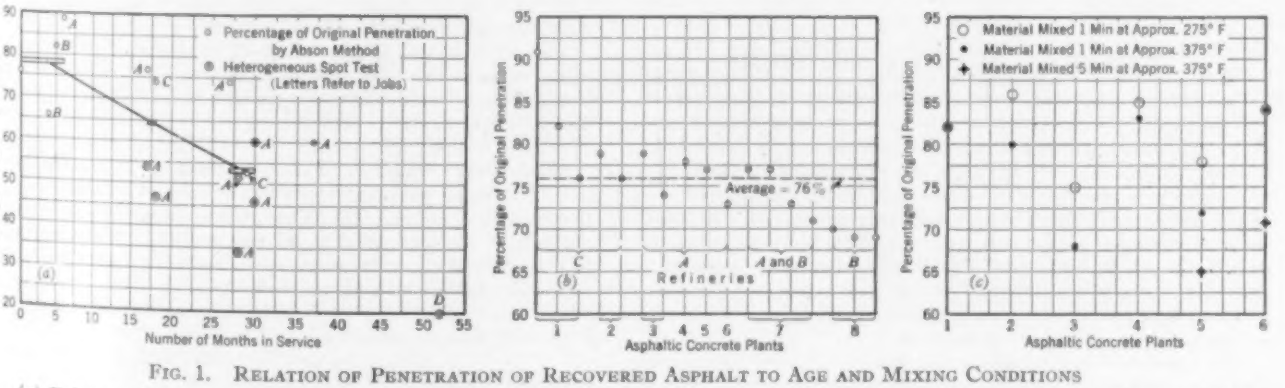


Fig. 1. Relation of Penetration of Recovered Asphalt to Age and Mixing Conditions
(*a*) Relation of Penetration to Age (*b*) Variation of Penetration with Plants (*c*) Relation of Penetration to Mixing Conditions

Recalling Experiences on the Roosevelt Dam Project

TO THE EDITOR: Friends of Louis C. Hill are gratified at his election as President of the American Society of Civil Engineers for 1937. The references, in the February issue of CIVIL ENGINEERING, to the Roosevelt Dam project and to his early experiences on the preliminary work, bring back many pleasant memories. When he took charge I was there as a part of that small, pioneering organization and so observed personally many of the experiences that he contributed to engineering history on that project.

It was in 1903—and I was a boy only part way through college, on my first engineering job. To me it is a memorable year, for it was then that the foundation of my future was laid. So it is all as vivid as though it were yesterday—the many happenings, the men associated with the work, and the opportunities a young fellow had to show what he could do. This boy deeply appreciated instruction, recognition, and encouragement, and the chance to make good. He was seriously ambitious and sincerely grateful for the kind interest of a superior, which gave him confidence and made him want to do his best.

That appreciation has ripened, during the years, into the realization that it is those human qualities of kindness, friendship, and sympathetic understanding, and a genuine interest in the fellow on the way up, which distinguish the real leader. Men reach the top because, besides technical ability and all the other essentials, they have the respect and admiration of loyal subordinates. Mr. Hill succeeded because the young men under him respected and admired him—as a man as well as an engineer. He helped and encouraged and inspired them, and let them share his difficulties and responsibilities. He made friends of his employees and associates. This I know as one of them, and it is a pleasure to say now what it meant to me.

One specific instance of his thoughtfulness stands out in my mind. I had been granted a leave of absence for the Christmas holidays, and with another man was planning to make the horseback trip over the trail and across the desert to Mesa, and from there to Phoenix. I do not recall that we were much concerned about our ability to find our way, although we realized later why we should have been. But when Mr. Hill found out about the trip he took time to make sketches and give me detailed directions to guide us at critical points. We later had good reason to appreciate these instuctions. The sketches and directions were so explicit that I recall marveling at the time at his observation of details, and ability to sense where we might have trouble.

I was grateful, as was only proper; but it was something more than that which filled me with pride and a feeling of importance. Mr. Hill, the engineer in charge—a busy man, with the responsibility of a large project on his shoulders—had taken enough interest in one of his subordinates to go out of his way to see to it that I made a safe trip. He made me realize that the most valuable asset to an engineer, or the head of any organization, is the love and respect and admiration of his subordinates and associates. And I learned from him that the way to merit that esteem is to treat them as sensitive, ambitious, conscientious individuals.

M. R. KAYS, M. Am. Soc. C.E.
Superintendent and Chief Engineer,
Lake Worth Drainage District

West Palm Beach, Fla.
February 20, 1937

Registration in California

DEAR SIR: I have just read the letter by E. T. Thurston, M. Am. Soc. C.E., printed in the February issue of CIVIL ENGINEERING, and commenting on an apparent inconsistency in relation to the number of civil engineers in California. He infers that the California Board of Registration for Civil Engineers, "despite the intent of the law," registered all branches of engineers as civil engineers—in fact, registered all persons willing to pay the registration fee, during the early history of the Board when the "grandfather clause" was in effect. Judging from my past experience as member and president of the California Board of Registration, Mr. Thurston is very much in error in his statement.

The California law regulates the practice of civil engineering. The law as passed in 1929 did not contain definitions of "civil engineer" or "civil engineering," although these definitions, as originally adopted in the rules of the Board and followed during the period when the "grandfather clause" was effective, have since been included in the law. The law provided that any person practicing civil engineering should be registered under it, with certain exemptions. It provided that any person registered must have spent six years in the practice of civil engineering, having been in responsible charge of civil engineering work for one year of this period. It provided that graduation from an engineering school of recognized standing should count for four years of such practice. The definition of civil engineering as adopted was the result of a very detailed study, during which all literature on the subject was reviewed, many leading civil engineers throughout the nation were consulted, and the definition finally adopted was submitted for criticism and comment on a wide scale. It is far from being the "generic definition" and was not interpreted as such by the Board.

Many engineers engaged primarily in branches of engineering other than civil engineering are called upon from time to time to practice civil engineering. Many of these men applied for registration under the law, and where they met the qualifications were issued certificates. The fact that on July 25, 1936, there were 4,346 persons registered as civil engineers under the California law means merely that 4,346 persons had met the requirements set forth in the law, and only that. Some of these persons were practicing civil engineering, some mining engineering, some were contractors, and some were businessmen, bankers, and lawyers.

The 1930 census figures are for "civil engineers and surveyors gainfully employed" at the time of taking the census, and includes those who have classified themselves as such, whether they are registered or not and whether they are in responsible charge of work or not. It does not include those who are not gainfully employed in civil engineering or surveying.

The fact that a person is allowed by law to practice civil engineering in California, because he has certain qualifications which the Board of Registration (the agency empowered to do so) has considered adequate, does not mean that he was gainfully employed in such profession at the time the census enumerator questioned him. The roster of registered civil engineers in California and the number of civil engineers shown to be registered therein cannot be compared with the number of civil engineers and surveyors gainfully employed as shown in the census, as there is no common ground for such comparison.

DONALD M. BAKER, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
February 24, 1937

Memories of Past-President Francis

TO THE EDITOR: I was interested in the biographical sketch of James Bicheno Francis, eleventh President of the Society, in the February issue of CIVIL ENGINEERING. In particular I noted that the safety gate, called "Francis' Folly" had been of service last year but at only one other time, 84 years previously, evidently in 1852. It had been my impression that the last prior use was in some flood in the eighteen seventies.

Incidentally, you may be curious to know why these matters all have such a very personal interest for me. They are associated with my early recollections. My father, Noah Richardson Harlow, was employed from 1864 until his retirement in 1887 as paymaster and clerk of the Proprietors of Locks and Canals. Whenever I visited him at his office I was cautioned to step lightly and make no noise, for Mr. Francis would not be disturbed.

This story is told of him. A plan, in which an error had been made, came to his office. He called his son whom we knew as "the Colonel" and told him to ascertain who had made the error and to discharge him at once. However, it turned out to be the Colonel's error, and nothing was done.

Another story about Mr. Francis concerns one of the covered canals. This canal was lined with wooden boards, which had worn very thin. After they were taken out, a man removed them without authority. He was called to account by Mr. Francis, who spoke to him sharply about stealing. As a matter of fact, the company was saved having to haul the rubbish away. Mr. Francis was a hard "boss." However, away from home, at a convention, he was a pleasant man to meet, I am told.

GEORGE R. HARLOW, M. Am. Soc. C.E.

Cleveland, Ohio
February 15, 1937

Lessons from Hydraulic Dredging Experiences

To the Editor: It is not my intention here to criticize the operations of the dredges at Fort Peck, as described by T. B. Larkin, M. Am. Soc. C.E., in the October issue of Civil Engineering. However, the data submitted on pipe-line velocities, output, kilowatt-hour per cubic yard, and high vacuum warrant some comments. In the ordinary dredge work the greater part of the pressure developed at the pump is used up in velocity friction. The loss varies as the square of the velocity. Thus far the transportation power dissipated at Fort Peck has been due mostly to friction and not to elevation.

Recently in the San Francisco Bay area a dredge with 2,500-hp motor and 24-in. pump completed a long highway fill some three and one-half miles in length, using 24-in. pipe on 2,000 ft of pontoon line, and $26^1/_2$-in. pipe on the remaining 18,000 ft. A yardage of 4,000,000 was involved. The work was completed in ten months. The latter part required the assistance of a booster pump. The remarkable feature of the work, when compared to the Fort Peck operations, is that the pipe-line velocity was only 15 ft per sec rather than 21.7 or higher. This means that only 35 per cent of the power is required for the low velocity. The high velocity would have required the use of four pumps, rather than two, to complete the work.

For this work new methods were used to analyze the operations and to determine the limitations of the dredge output and its efficiency. Practically all dredges are operated by the trial-and-error method, and one of the objectives was to prove or disprove some of the fixed ideas on dredging practices, which border on superstition and have no logical explanation. The equivalent of a Venturi meter, which recorded the water velocity and also indicated the specific gravity of the fluid passing through the pump, was installed on the pipe discharge. The ordinary pressure and vacuum readings used by the operator to control the loading of the pump were recorded simultaneously with the loading chart. Rapid clock movements were used to spread the readings on the chart. It was deduced that the machine should deliver at least 1,200 yd per hr of excavation, although the actual output averaged 900. This could have been done with the use of very little more power. On the basis of a 24-in. pump handling 1,200 yd per hr, the 28-in. pump would handle about 1,650 yd, or near the Fort Peck records.

In view of the disclosures made by the use of the new meter, a high vacuum should not be accepted as a measure of operating efficiency. The vacuum gage has been wrongly interpreted as indicating the amount of solids entering the pump. It can now be proved that this interpretation is grossly inaccurate. Besides the anticipated entrance loss in the suction, friction loss due to velocity, and extra vacuum due to materials heavier than water, there may be a very important clogging effect. It may be considered that there are the following three stages of pipe flow: (1) Water, (2) water plus solids, which are free in suspension, and (3) water plus solids, with the latter arranged in such a manner that the water channels at a high velocity around the solids and dissipates the flow energy without properly moving the solids.

At the beginning of this experimental work it soon became apparent that the dredging could be conducted differently from past dredging practices. The chief point of difference was the selection of a $26^1/_2$-in. pipe which costs no more than the 24-in. pipe on account of the stock plate sizes. In dredging circles it is universally believed that calamity is in the offing unless the diameter of discharge pipe is the same as the pump discharge. This and other ideas were proved false when applied to a modern electric dredge with ample power.

Dredge operation is a complicated subject, and many factors must be taken into consideration to ensure economical operation.

Arthur L. Collins, Assoc. M. Am. Soc. C.E.
Consulting Engineer

Berkeley, Calif.
March 1, 1937

Advantages of Parkways and Freeways

To the Editor: In his article on "Effect of Major Highways on Their Districts," in the January issue, U. N. Arthur, M. Am. Soc. C.E., adequately describes the effect of major highways upon the districts traversed in the Pittsburgh region. It is safe to assume that similar conditions prevail in and about every large city in the United States. Small cities and villages will ultimately suffer also, unless the rapid depreciation of land values and the resultant economic losses caused by the passage of through traffic over local city and village business and residential streets can be prevented.

The motorway must be considered a more important factor in the development of the region, state, and nation than it has been heretofore. Several state officials are now giving the matter of motorways careful consideration. They realize that many of our highways are unsafe and that radical changes must be made to reduce the increasing number of automobile accidents. It seems to me that the one really satisfactory solution is to provide enabling legislation to permit the state highway departments to construct "freeways" instead of highways.

Recently the governor of New York recommended to the legislature that attention be directed to the elimination of structures along roadsides, which destroy the appearance of the countryside, reduce the efficiency of the road, and are contributory causes of accidents. Therefore the New York State Planning Council advocates the construction of freeways instead of highways as the best method of carrying out the governor's recommendation. Zoning may be a means of reclaiming old highways, but new roads must be developed upon broader and more comprehensive lines.

In constructing freeways careful consideration should be given to the topography. It now seems desirable to construct two separate roads, one for traffic in each direction. A four-lane freeway might consist of two 24-ft roadways (two 12-ft lanes), and a six-lane freeway, of two 34-ft roadways (each right-hand outside lane 12 ft wide, and the other lanes 11 ft wide). In certain cases, in this Pittsburgh region, it would be advantageous to construct these two drives at different levels and at varying differences in elevation and varying distances apart in order to adapt them to the terrain. Further refinements include the careful spiraling of curves; the elimination of tangents between curves in the same direction; widening the pavement at curves; the careful grading of slopes to adapt the roadways to the newly graded right of way; the appropriate design of bridges and grade-elimination structures, with attention to the artistic design of guard-rails and signs; and the careful planting of slopes and other adjacent areas.

I believe that the city and the region within a large radius about it should be carefully studied in order to determine the best locations for major arteries to be built within the next ten to twenty-five years. Then, as each new project reaches the construction stage, it may be considered part of a careful plan for a well-organized network of regional arterial ways.

According to Mr. Arthur, all new and relocated major routes should be so planned that they will safely carry traffic at a speed of 100 mph. I do not subscribe to this theory. It need hardly be stated that motorists are not capable of driving safely at that high rate of speed, and it is safe to predict that ordinary driving speeds probably never will exceed 50 mph. At present, we cannot afford to design roads for speeds much greater than this. In the first place curves superelevated for even this speed are exceedingly dangerous in the winter months and, in the second, the capacity of a road upon which high speeds are permitted is materially reduced. It goes without saying that, even on roads designed for speeds of 50 mph and over, all grade crossings should be eliminated. Conservatism with respect to speed seems to be a wiser procedure.

Gilmore D. Clarke, M. Am. Soc. C.E.
Consulting Landscape Architect, Westchester County Park Commission and New York City Department of Parks

White Plains, N.Y.
March 1, 1937

Some Considerations in Highway Safety

To the Editor: In his paper on "Important Considerations in Highway Design," in the January issue, W. V. Buck, M. Am. Soc. C.E., has fully covered most of the important points. Of late the elimination of highway and railroad grade crossings has been undertaken rather extensively in the interest of employment and safety, and it is true that the improvement of the highway is sometimes slighted in favor of the railroad. Unless modern standards of curvature, sight distance, and width are given more consideration, much of the work that is now being done will require major revision at public expense within a few years.

Mr. Buck's comments on esthetic considerations in highway construction are also very timely and valuable. Roadways should harmonize with their surroundings as if they grew and belonged there, and necessary adjustments should be made in such a manner that misfits will not be too obvious. It is the policy of some states to remove all topsoil within the limits of the construction and to redistribute it on the slopes, seed, and fertilize it. This takes away unsatisfactory material from the body of fills, helps decrease erosion maintenance, and improves the appearance of the work.

It is not clear to me why vertical and horizontal curves should not overlap. Some believe that the overlapping makes for better design in that appearance is much improved, especially at summits, and that the tendency to decrease speed for the one condition is beneficial for the other. Vertical curves, particularly, should be lengthened to the limit if the best appearance is to be obtained. Flat horizontal curves compounded can well take the place of spirals, but great care should be given to see that change of curvature is not too abrupt. The introduction of longer and flatter curves in place of tangents enables drivers to adjust their speed to average driving conditions and gives greater uniformity of control.

The three-lane road has been much condemned. While it is more dangerous than the two-lane road, it is not so dangerous as the four-lane undivided road. The three-lane road may be regarded as a stop-gap until funds become available for a four-lane divided road, when one of the lanes can be converted into an island and two more lanes added. The idea of dividing the two-lane road is a new but interesting one. Six-lane roads are necessary in a few places for short distances, but they should always be patrolled to regulate speed.

The problem that is giving highway designers and administrators the most trouble is that of intersections. The installation of traffic circles and grade separations has been a favored solution, but because of the complexities of the problem many of these have not always been as satisfactory as anticipated. When analyzed in terms of expedition of traffic, safety, and increased return on an investment already made, their benefits and justification become more apparent.

Unfortunately, however, modern standards of alignment, width, grades, and sight distances, with grade separations, traffic circles, and wide island intersections, do not necessarily make highways safe. A few drivers will not use ordinary care and are reluctant to reduce speed for other vehicles, darkness, rain, or icy surfaces and the highway engineer can do but little to prevent negligence and high speed. The underlying cause of almost every accident is operation at a speed higher than the conditions warrant. The qualification, training, and control of the driver are the only things that are expected to have any appreciable effect on the accident rate.

These comments are not intended to discourage the engineer in striving for safety in design, construction, and maintenance. Although his part in safety attainment is small, it is nevertheless beneficial to drivers and economical for the public. The engineer should see that his small part is so well played that the responsibility for abuse of his works cannot be placed on his head.

H. W. Giffin, Assoc. M. Am. Soc. C.E.
Engineer of Surveys and Plans, New Jersey State Highway Department

Trenton, N.J.
March 3, 1937

Soil Mechanics and Ohio Highways

To the Editor: In his paper on "Soil Mechanics in Highway Construction," in the January issue, A. B. Woods, Jun. Am. Soc. C.E., has capably covered his subject. A few applications of soil mechanics to Ohio projects will be of interest in this connection.

Soon after the Muskingum Water Conservancy District began to function, it became apparent that a number of highway embankments would be made necessary by the creation of the dam pools. The 1935 specifications of the Ohio State Highway Department provide that all fills to be constructed of materials containing particles, of which 54 per cent or less are retained on the No. 200-mesh sieve, shall be built in 8-in. layers and be compacted by wetting and rolling. The rolling of the soil at or near the optimum moisture content was to be continued until each layer attained 90 per cent of the maximum compaction of the dry weight-optimum moisture curve for the same material. For projects lying within the pool stage of the Conservancy District, even more exacting specifications were written, in which it was specified that layers were to be not more than 6 in. thick, and were to be rolled until each layer attained 94 per cent of the maximum density obtained from the dry weight-optimum moisture curve. These projects were subsequently placed under contract and are now in the process of construction. Compaction tests, made by determining the density of the soil layers from borings, show that the specifications are being substantially carried out.

While the Ohio specifications do not permit the application of water to fill materials by sprinkling hose, this method has been used advantageously on the conservancy dam projects. It is believed that this method of applying water has real merit, is practicable, and should be adopted for highway embankments whenever it is necessary to haul water for long distances or where a pipe line is available for other purposes.

The project in Ashland County, Ohio, cited by Mr. Woods as being constucted by floating the embankment on a peat foundation, is also located in the Conservancy District. Compaction of the wetted soil was here obtained by continuously operating tamping rollers over each layer. Travel over the surface by the hauling units aided in the compaction process, provided they made no travel lanes. Rolling was continued until core tests showed the required density. The fills on this project are about 85 per cent complete at this time, and elevations taken to determine the amount of settlement show an average observed settlement on the main road of about 0.6. A settlement of 9 in. has been reported under a load of 9 ft in a swampy location, where the maximum fill will be 13 ft. No side upheaval can be noted, and it is believed that the crust has arched concave upward under the load.

Mr. Woods has called attention to the fact that variations in excavated material make it difficult to apply the specification for compaction based on a percentage of the maximum density obtained from the optimum moisture curve. Where wheel-scrapers or elevating graders are used, excavated materials do not vary daily from that upon which the curve was based. If shovels are used, a different condition obtains, as the materials vary in characteristics and proportions frequently during the working day. For such cases it may be desirable to provide traveling laboratory units to supply density curves with a minimum delay whenever needed.

The personal element in the making of compaction tests, to which Mr. Woods calls attention, is present in any test procedure. It will continue to be a problem, until the men engaged in making the field tests are thoroughly trained and some means is developed of checking their technique with that of the men in the laboratory.

It must be conceded that the selection of proper materials for use in fills by observation alone requires considerable skill, and even then the method is not infallible. During construction, a quick and accurate method is necessary for determining whether a material shall or shall not be used. While no method of determining this quickly is available, the relations between the compacted dry weight and the soil behavior classification, described by Mr. Woods, are extremely interesting.

August Schofer, Assoc. M. Am. Soc. C.E.
Associate Highway Engineer, U. S. Bureau of Public Roads

Columbus, Ohio
March 2, 1937

The Historic Mission San Jose in San Antonio, Tex.

Spring Meeting in San Antonio, Tex.

Plaza Hotel to Be Headquarters for Gathering, April 21–24, 1937

Opening Session

WEDNESDAY—April 21, 1937—Morning

9:00 **Registration**

10:00 **Spring Meeting called to order by**

E. W. Robinson, *President, Texas Section, Am. Soc. C.E.; Vice-President and Treasurer, McKenzie Construction Company,* San Antonio, Tex.

10:05 **Addresses of Welcome**

His Excellency James V. Allred, *Governor of the State of Texas, Austin, Tex.*

His Honor C. K. Quin, *Mayor of the City of San Antonio, Tex.*

Response

Louis C. Hill, *President, American Society of Civil Engineers; Consulting Engineer,* Los Angeles, Calif.

10:30 **Symposium on the Resources of the State of Texas**

Introduction

W. M. Massie, *Esq., Chairman, The Texas Planning Board,* Fort Worth, Tex.

WEDNESDAY—April 21, 1937—Afternoon

12:30 **Local Sections Luncheon ("Mexican Dinner") at Original Mexican Restaurant**

Sponsored by the Texas Section. All members and their ladies are requested to attend.

W. O. Jones, *Vice-President, Texas Section of the Society; Assistant City Engineer,* Fort Worth, Tex., chairman.

Tickets 75 cents each.

General Meeting

WEDNESDAY—April 21, 1937—Afternoon

H. W. Dennis, *Vice-President, Am. Soc. C.E., Presiding*

2:00 **Symposium on the Resources of the State of Texas**

(1) **Water Resources of Texas**

John W. Pritchett, *Assoc. M. Am. Soc. C.E., Member, State Board of Water Engineers,* Austin, Tex.

(2) **Railroads of Texas**

George C. Smith, *Esq., Assistant to the President, Missouri-Kansas-Texas Lines,* St. Louis, Mo.

(3) **Agricultural Resources of Texas**

F. A. Buechel, *Esq., Assistant Director, Bureau of Business Research, The University of Texas,* Austin, Tex.

(4) **Forest Resources of Texas**

E. L. Kurth, *Esq., Vice-President and General Manager, Angelina County Lumber Company,* Keltys, Angelina County, Tex.

(5) **Mineral Resources of Texas**

E. H. Sellards, *Esq., University of Texas,* Austin, Tex.

(6) **Industrial Possibilities of Texas**

W. B. Tuttle, *Esq., Chairman of the Board, San Antonio Public Service Company,* San Antonio, Tex.

2:30 **Student Chapter Conference**

A conference of representatives from Student Chapters in the vicinity will be held on Wednesday afternoon, April 21. In addition to members of Chapters, faculty advisers, and contact members, a cordial invitation is extended to members of the Society to attend the student meeting.

WEDNESDAY—April 21, 1937—Evening

7:00 **Dinner-Dance and Entertainment "in the Mexican Manner"**

For members, ladies, and guests in the ballroom of the Plaza Hotel.

Toastmaster, Datus E. Proper, *Assoc. M. Am. Soc. C.E., Vice-President and General Sales Manager, Uvalde Rock Asphalt Company,* San Antonio, Tex.

Dancing 10:00 to 1:00.

Tickets $2.50 each. Tickets for the dance only will be available to Students without charge.

Sessions of Technical Divisions

THURSDAY—April 22, 1937—Morning

HIGHWAY DIVISION

10:00 A State-Wide Highway Planning Survey

G. G. EDWARDS, *M. Am. Soc. C.E., Manager, Texas Highway Planning Survey*, Austin, Tex.

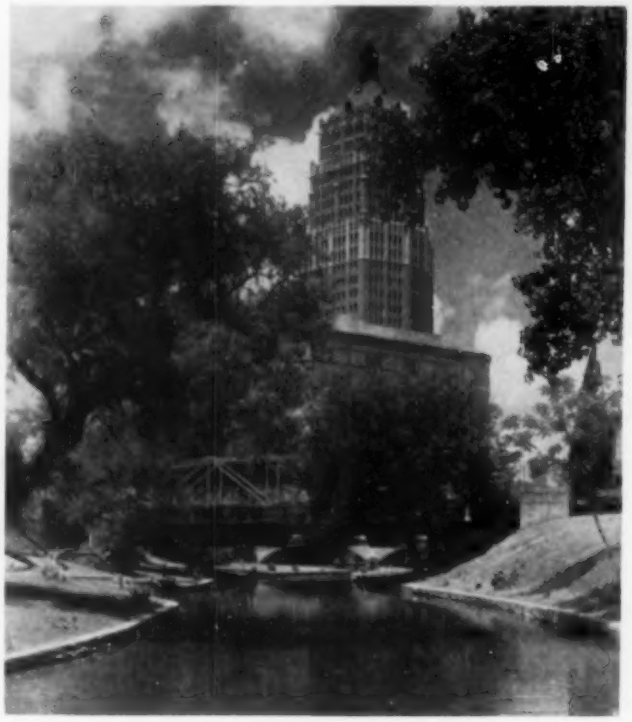
10:30 Highway Construction in the Chisos Mountains

C. D. WELLS, *Esq., Construction Engineer, State Highway Department*, Austin, Tex.

11:00 Highways in Mexico

JOHN E. BLAIR, *Esq., Division Engineer, State Highway Department*, Bryan, Tex.

11:30 Discussion



SAN ANTONIO RIVER WITH SMITH YOUNG TOWER IN BACKGROUND

IRRIGATION DIVISION

10:00 Methods Used on the Investigations of the Underground Water Resources of Texas

SAMUEL F. TURNER, *Esq., Associate Hydraulic Engineer, U. S. Geological Survey*, Austin, Tex.

10:30 Watershed Development

T. C. FORREST, JR., *Assoc. M. Am. Soc. C.E., Consulting Civil Engineer*, Dallas, Tex.

11:15 Irrigation from Wells by Pumping

WINFIELD HOLBROOK, *Assoc. M. Am. Soc. C.E., General Manager, Texas Land and Development Company*, Plainview, Tex.

11:45 Discussion

SURVEYING AND MAPPING DIVISION

10:00 Engineering Work of the International Boundary Commission, United States and Mexico

L. M. LAWSON, *M. Am. Soc. C.E., Commissioner of the United States, International Boundary Commission*, El Paso, Tex.

10:45 Discussion opened by

E. N. NOYES, *M. Am. Soc. C.E., Consulting Civil Engineer*, Dallas, Tex.

11:00 The Resurvey of the University of Texas Lands

FRANK F. FRIEND, *Esq., Special Surveyor, University of Texas Lands*, San Angelo, Tex.

11:45 Discussion opened by

W. J. POWELL, *M. Am. Soc. C.E., Consulting Engineer*, Dallas, Tex.

ADMINISTRATION BUILDING, RANDOLPH FIELD
San Antonio, Tex.

PICTURESQUE VIEW OF BRACKENRIDGE PARK
Japanese Tea Garden

Occupy the Entire Day

THURSDAY—April 22, 1937—Afternoon

CONSTRUCTION AND STRUCTURAL DIVISIONS

2:00 **The New Causeway at Galveston**

C. Terrell Bartlett, *M. Am. Soc. C.E., Consulting Engineer*, San Antonio, Tex.

2:30 **The Design of the San Jacinto Memorial**

Robert J. Cummins, *M. Am. Soc. C.E., Consulting Engineer*, Houston, Tex.

3:00 **Motion Pictures with Explanatory Comments on Soil Mechanics Laboratory at U. S. Waterways Experiment Station, Vicksburg, Miss.**

Spencer J. Buchanan, *Assoc. M. Am. Soc. C.E., Associate Engineer, U. S. Waterways Experiment Station, Mississippi River Commission*, Vicksburg, Miss.

3:30 **Discussion**

SURVEYING AND MAPPING DIVISION

2:00 **The Application of Modern Surveying and Mapping to Engineering Practice**

J. C. Carpenter, *M. Am. Soc. C.E., Senior Highway Engineer, U. S. Bureau of Public Roads*, Fort Worth, Tex.

2:45 **Discussion opened by**

Harry B. Henderlite, *M. Am. Soc. C.E., State Highway Engineer, State Highway Commission*, Baton Rouge, La.

3:00 **Mapping and Surveying Activities of the Brazos River Conservation and Reclamation District**

Eric Haquinius, *M. Am. Soc. C.E., Chief of Surveys, Brazos River Conservation and Reclamation District*, Temple, Tex.

3:45 **Discussion opened by**

John W. Pritchett, *Assoc. M. Am. Soc. C.E., Member, State Board of Water Engineers*, Austin, Tex.

Alamo Plaza with Medical Arts Building in the Background

IRRIGATION DIVISION

2:00 **Flood Flow of Texas Rivers**

C. E. Ellsworth, *Assoc. M. Am. Soc. C.E., District Engineer, U. S. Geological Survey*, Austin, Tex.

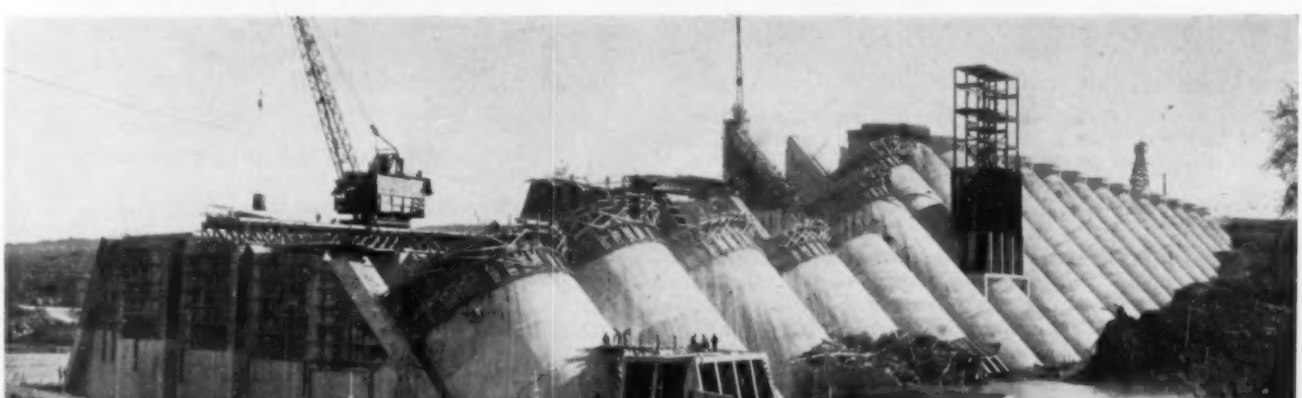
3:00 **Irrigation of Rice**

E. N. Gustafson, *M. Am. Soc. C.E., Highway Engineer, Portland Cement Association*, Austin, Tex.

4:00 **Measurement of Irrigation Water**

H. H. Kidder, *M. Am. Soc. C.E., Irrigation Engineer*, San Juan, Tex.

4:30 **Discussion**



Upstream View of Buchanan Dam of the Lower Colorado River Authority, Scene of Friday Inspection Trip

THURSDAY—April 22, 1937—Evening

5:30 **Stag Barbecue**

The members and their friends (men only) will assemble at the Plaza Hotel. Cars will be waiting to take them to the country for a "Stag Barbecue."

Tickets may be obtained at the Registration Desk not later than Wednesday night. No charge.

See announcement under entertainment for the ladies as to how the ladies will be cared for on this evening.

Entertainment for the Ladies

WEDNESDAY—April 21, 1937

During the morning the visiting ladies will register at headquarters and will be greeted by members of the Ladies Committee.

12:30 Luncheon

Ladies may join the members for the Local Section luncheon (a "Mexican Dinner") at the Original Mexican Restaurant.

Tickets 75 cents each.

2:00 Scenic Tour

Ladies will assemble at the Plaza Hotel at 2:00 p.m. where cars and buses will be waiting to take them on a tour of the city for visits to many attractive and scenic points of interest.

No charge, but obtain ticket at Registration Desk.

7:00 Dinner Dance

Ladies will join the members for the dinner dance at the Plaza Hotel.

THURSDAY—April 22, 1937—Morning

10:00 Drive for Ladies

Ladies will assemble at the Plaza Hotel at 10:00 a.m., where cars and buses will be waiting to take them on a tour of the Spanish Missions. A stop will be made at the most important of these, Mission San Jose, for a lecture on its history and restoration.

No charge but obtain ticket at Registration Desk.

THURSDAY—April 22, 1937—Afternoon

12:15 Ladies' Luncheon

Visiting ladies will assemble at the St. Anthony Hotel to attend the "Battle of Flowers" luncheon, one of the important social events of the year. It is always uniquely decorated and provided with musical and dance numbers by first-rate artists.

Admission by invitation. A block of tickets has been obtained for visiting ladies of the American Society of Civil Engineers.

No charge but obtain ticket at Registration Desk.

(This luncheon terminates about 3:00 p.m.)

6:30 Buffet Supper

Ladies will assemble at St. Anthony Hotel for a Buffet Supper.

No charge but obtain ticket at Registration Desk.

8:00 "Coronation of the Queen"

Ladies will assemble at the city auditorium—two blocks from the St. Anthony Hotel—to attend the "Coronation of the Queen." This is the most important social event of the year in San Antonio. A brilliant spectacle in honor of the season's debutantes, with gorgeous dresses, artistic stage show, "coronation" ceremony. All ladies guaranteed an unforgettable evening.

Tickets $3.50 each.

FRIDAY—April 23, 1937

Ladies will join the members who elect to go on the various excursions listed for this day.

Excursions on Friday, April 23, 1937

Members are requested to obtain their tickets for choice of following excursions by noon on Thursday, April 22, 1937.

8:00 Excursion "A"

Leaving Plaza Hotel. A tour of Army posts and historic buildings, returning at noon. Cars and buses will be provided. Obtain ticket but there is no charge.

8:00 Excursion "B"

Leaving Plaza Hotel. An all-day trip will be made to the Buchanan Dam of the Lower Colorado River Authority, now in an advanced stage of construction. It is approximately 100 miles north of San Antonio in the beautiful "hill country." Luncheon will be had at the dam.

Obtain ticket but there is no charge.

(Those taking this trip will return to San Antonio too late for the parade or Excursion "C.")

4:00 "Battle of Flowers Parade"

A famous annual event in San Antonio, with attractive floats—a festive and historic occasion. Several thousand troops from military posts, representing all branches of the service, will participate.

A block of seats has been reserved in the grandstand, near the Alamo.

Tickets $1.00 each. The parade may be observed along the side line of streets for nothing.

(Those intending to go on the Monterrey excursion cannot attend this parade for want of time.)

4:45 Excursion "C"—Trip to Monterrey, Mexico

Depart on Missouri Pacific train for post-convention visit to Monterrey in Old Mexico.

This will be contingent upon the purchase by members and guests of at least 15 tickets at the Registration Desk before noon of Thursday, April 22, 1937, and will be canceled in case the minimum guarantee cannot be met.

The trip will be made in chartered, air-conditioned Pullmans, via Missouri Pacific Railroad, leaving San Antonio at 4:45 p.m., Friday, April 23, 1937, arriving in Monterrey at 2:20 a.m., Saturday, April 24. The cars will be set out in Monterrey for use of the party in lieu of a hotel.

All day Saturday and Saturday evening will be devoted to sightseeing and entertainment in this beautiful as well as industrial city of Old Mexico.

Returning, the party will leave Monterrey at 7:50 a.m., Sunday, April 25, arriving in San Antonio at 8:15 p.m. that night, making connections for all points.

Approximate cost per person $35, exclusive of meals and entertainment.

See Page 31 for Advance Registration and Ticket Order Card

Hotel Accommodations and Announcements

In order to be certain of accommodations, members are urged to make definite arrangements for rooms by Saturday, April 17, paying for rooms in advance for at least a part of the period during which they expect to be in San Antonio. Reservations should be made direct with the hotel, but a copy of the letter requesting the registration should be mailed to W. H. Lilly, Milam Building, San Antonio, Tex., for assistance in effecting arrangements.

The Plaza Hotel is the Meeting Headquarters and, it is expected, will be able to care for all who attend.

Hotel Rates

Hotel	Single Rooms With Bath	Double Rooms With Bath
Plaza	\$2.50 up	\$3.50 up
St. Anthony	3.00 up	4.00 up
Gunter	2.50 up	3.50 up
Robert E. Lee	2.00 up	3.00 up
Blue Bonnet	2.00 up	3.00 up

All who attend the Spring Meeting are requested to register immediately upon arrival at headquarters. Special badges and tickets will be obtained at the time of registration.

Local Section Conference, Tuesday, April 20, 1937

A conference of representatives from Local Sections will be held on Tuesday, April 20, at 2:30 p.m. Accredited representatives from the fifteen Local Sections in the Southern Meeting Region will discuss Local Section affairs. The conference is held under the sponsorship of the Southern Region Meetings Committee, of which H. W. Dennis, Vice-President, Am. Soc. C.E., is chairman. All members of the Society will be welcome to attend.

Student Accommodations

The Plaza Hotel will provide students with accommodations, dormitory style, with bath, 3 to 6 students in a room, at from \$1.00 to \$1.50 each per day.

Highway Information

San Antonio is accessible by a complete system of paved roads. Information on routing will be furnished by the San Antonio Chamber of Commerce.

Entertainment

Attention is directed to the program for entertainment. This side of the Meeting will be stressed, and all are encouraged to participate. Distinctive and special entertainment has been arranged. The Spring Meeting takes place during "Fiesta Week," a traditional and colorful celebration famous for military displays, historical pageants, and "society" on parade. The local committee has carefully considered the visiting ladies in planning their entertainment. Close attention to this part of the program is urged on everyone.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved delay by having tickets and badges awaiting them on arrival at headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements.

Information

A registration desk will be provided in the headquarters hotel to assist visiting members in securing desired information about the city. At the registration desk a card file of those in attendance will be maintained, with information as to San Antonio addresses.

Invitation to Student Members

Members of Student Chapters are invited to attend and participate in all the events of the Spring Meeting.

Weather Information

The temperature in San Antonio in April has a daily average mean of 69 F, an average maximum of 80 F, and an average minimum of 59 F. Spring clothing is desirable.

Meeting of Mid-South Section, Memphis, Tenn, April 16–17, 1937

Members attending the Spring Meeting in San Antonio may arrange their itineraries so as to be in Memphis April 16 and 17 for the meeting of the Mid-South Section. The Section extends a cordial invitation to all to attend.

Local Committee on Arrangements

E. W. Robinson, *President Texas Section*
General Chairman

Executive Committee

E. P. Arneson, *Chairman*

Fred Bramlette, J. T. L. McNew, Harry B. Friedman, Datus E. Proper, Grayson Gill, E. W. Robinson, W. S. Goodman, W. E. Simpson, Mrs. H. R. F. Helland, R. G. White, W. H. Lilly, E. A. Wood

Hotel Arrangements and Registration Committee

W. H. Lilly, *Chairman*

E. A. Baugh, W. O. Jones, M. L. Diver, W. Kenan, H. R. F. Helland, J. T. L. McNew

Entertainment Committee

Datus E. Proper, *Chairman*

J. H. Briggs, J. M. Howe, F. T. Drought, Don Lee, H. R. F. Helland, A. J. McKenzie, Walter Meier

Ladies Entertainment Committee

Mrs. H. R. F. Helland, *Chairman*

Mrs. E. P. Arneson, Mrs. A. J. McKenzie, Mrs. C. Terrell Bartlett, Mrs. Datus E. Proper, Mrs. F. T. Drought, Mrs. E. W. Robinson, Mrs. N. A. Saigh

Transportation Committee

R. G. White, *Chairman*

R. A. Bossy, H. M. Matthews, H. S. Kerr, H. F. Stubbs

Technical Papers and Discussion Committee

E. A. Wood, *Chairman*

J. C. Carpenter, A. Tamm

Exhibits Committee

W. E. Simpson, *Chairman*

C. Terrell Bartlett, John Focht, J. C. Early, W. Kenan

Publicity and Printing Committee

W. S. Goodman, *Chairman*

E. A. Baugh, Don Lee, J. H. Briggs, D. G. McKim

Finance Committee

Fred Bramlette, *Chairman*

R. L. Brandt, C. F. Parker, W. E. Dickerson, N. A. Saigh

Regional Meeting Committee

The program as a whole has been prepared under the direction of the Southern Region Meetings Committee, with the following personnel:

H. W. Dennis, *Vice-President, Am. Soc. C.E., Chairman*

L. F. Bellinger, *Vice-President* — L. L. Hidinger, *Director*
E. P. Arneson, *Director* — T. Keith Legaré, *Director*

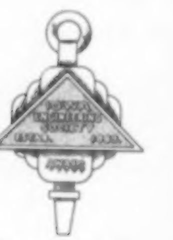
Please call on the Committee on Local Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Iowa Engineering Society Presents Annual Awards

THE FORTY-NINTH annual meeting of the Iowa Engineering Society was featured by a banquet held on March 3 at the Hotel Fort Des Moines, Des Moines, Iowa. A number of persons connected with the society membership and its notable history were honored. Various features of the program reflected the close associations and ties which bind this state-wide organization to the American Society of Civil Engineers.



FORM OF IOWA AWARD

Honorary membership in the Iowa Engineering Society was conferred upon Anson Marston, Past-President Am. Soc. C.E., and of the state society. Dean Marston has long been connected with both organizations and this honor indicates once more the deep esteem in which he is held.

One of the outstanding awards for recognizing engineering attainments in Iowa is named after John H. Dunlap, former Secretary Am. Soc. C.E., who died in office in 1924, after a brief term of two years. Professor Dunlap was a former president of the Iowa society. The John Dunlap Memorial Award, perpetuating his memory and marking engineering accomplishment, was awarded to R. B. Vaile of the University of Missouri for his paper, "A High Voltage Electrostatic Belt Generator."

A third event of importance at this meeting was announcement of the Anson Marston Award, which also is named in honor of a former officer of the national Society. This was presented to John S. Dodds, M. Am. Soc. C.E., for outstanding service during 1936. The award was in the form of a gold emblem, a line drawing of which is reproduced herewith.

The meeting was in charge of Q. C. Ayres, M. Am. Soc. C.E., retiring president. Professor Ayres is on the staff of Iowa State College. Election for the forthcoming year to this office was also announced; T. R. Agg, M. Am. Soc. C.E., Dean of Engineering Iowa State College, is thus honored.

Committee on Flood Control

BY AUTHORIZATION of the Board of Direction, a Committee on Flood Control has been appointed to make a general appraisal of flood-control methods, with particular reference to their physical and economic limitations. The committee consists of John F. Coleman, chairman; and C. B. Burdick, Harrison P. Eddy, L. L. Hidinger, E. W. Lane, A. W. Newton, and C. E. Sherman, all Members of the Society.

The importance of the new committee's assignment is pointed out in the following report adopted by the Board:

"There is a growing trend on the part of public officials and the public at large to look upon flood control as a remedy of ready application and as affording a dependable cure for flood hazards which have been permitted to develop throughout the United States.

"There is need for clarification of this trend of thought, with special reference as to what flood control in its various phases may be expected to accomplish.

"Many recognized methods have a bearing, direct or indirect, on this general problem. Levees, reservoirs, forestation, soil-erosion control, cut-offs, flood-plain clearance, are being widely discussed and considered. All of them come into the picture, here or there. All of them have their limitations. Moreover, the term 'flood control,' widely used, often without distinction as to degree, may convey to the public an erroneous impression as to actual results to be obtained.

"This is an opportune time to give consideration to the practical and economic limitations involved, and the Society may perform a real public service by so doing."

In This Issue . . .

Appointments of Society Representatives

IVAN E. HOUK and ARTHUR O. RIDGWAY, Members Am. Soc. C.E., have accepted appointments to represent the Society at the summer meeting of the American Association for the Advancement of Science, to be held in Denver, Colo., June 21–26, 1937.

INGE M. LYSE, M. Am. Soc. C. E., has been appointed one of the Society's representatives on the Division of Engineering and Industrial Research of the National Research Council to fill the vacancy caused by the death of JOHN H. GREGORY, M. Am. Soc. C.E.

Student Conference Abstracts Published

FOR THE BENEFIT of Student Chapters throughout the country, the Society has prepared a comprehensive digest of the conference held in New York on January 20. This report, an edited abstract of the stenographic transcript of the conference proceedings, has now been printed by photo-offset process and distributed to all concerned.

Of special interest is the section reporting the round-table discussion, which centered about two principal questions: "What should be the function of a Student Chapter on the university campus?" and "How should the activities of a chapter of a national professional society differ from those of a college social club or other campus organization?" The suggestions and comments of some twenty speakers are included.

The report also contains an abstract of the address by E. M. Hastings, Contact Member for the Virginia Military Institute Student Chapter. His subject was "The Student and His Relation to the Society." Two papers by students, delivered at the conference, are presented as appendices.

Mention should also be made here of the abstract of the Student Chapter conference held at Pittsburgh last October, which was prepared in similar form and distributed several weeks ago. Its highlights were an informal address by President Mead, and the round-table discussion on how the Student Chapter can be of most service to its members, and how the national Society, the Local Sections, and the Contact Members can be of most service to the Chapters. Inserted in each copy of the abstract was a reprint from the December 1936 issue of CIVIL ENGINEERING of the address by Harrison P. Eddy, Past-President Am. Soc. C.E., on "What an Employer Looks for in a Young Engineer."

Considerable effort on the part of the Headquarters' staff has gone into working the stenographic notes of these conferences into brief, readable form. The final abstracts should be found to contain something of value for every Student Chapter.

Early Presidents of the Society

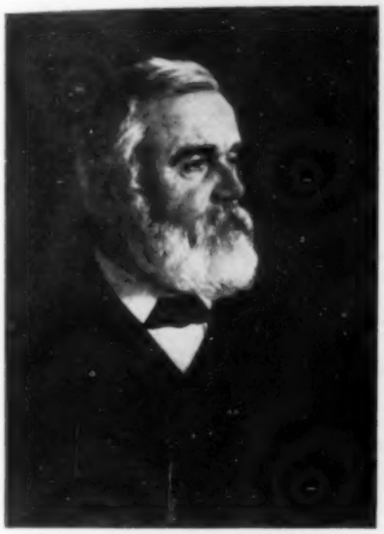
XIII. Charles Paine, 1830–1906

President of the Society, 1883

Among the present members of the Society there are doubtless some who came into intimate contact with Charles Paine in the latter years of his life. Such persons are requested to review this article carefully and submit any additional information that it is believed will be of interest to the Society's members. Information on Don Juan Whittemore, Frederic Graff, and Henry Flad, whose stories will appear in following issues, also will be appreciated.

"Now let us haste these bonds to knit
  And in the work be handy,
That we may blend 'God Save the Queen'
  With 'Yankee Doodle Dandy!'"

The occasion for this bit of doggerel was an international celebration held in Boston in 1851 to commemorate the completion of a system of railroads linking that city with Canada. President Fillmore was there, and the Secretary of State, and the Governor General of Canada, and a long list of other notables. There were concerts and speeches and parades, and the whole town gave itself over to gaiety.



Charles Paine
Thirteenth President of the Society

What this railroad link meant to Boston was typified by a float in one of the parades—a wagon bearing twenty barrels of West Virginia flour that had been brought there via the Ohio River and the Great Lakes to Ogdensburg, N.Y., and thence by way of the Ogdensburg and Vermont railroads to the seaboard.

Young Charles Paine, just turned 21, must have found a special thrill in that celebration. For three years he had carried on his youthful shoulders the responsibilities of a division engineer on construction of one of the main lines of the system, the Vermont and Canada Railroad. Barely at his majority, he had already had a noteworthy part in a great enterprise of international acclaim.

But perhaps he was even more proud that he had already demonstrated his ability not only to solve technical problems but to handle men. The latter ability was the foundation of all his later achievements. Charles Paine designed no outstanding structures; he made no notable discoveries or inventions; but as a manager and director of great organizations he had few peers among engineers. He combined intellectual superiority with the proper blend of courtesy, dignity, sympathy, and enthusiasm to win the allegiance of those who worked for him, and he took care to encourage and train them. After his death, another railroad executive remarked, "The country is full of Paine's men, and they are the best railroad officers we have."

How Paine Got Into Railroad Work

Paine was born in Haverhill, N.H., in 1830. His formal schooling was quite limited, but he was given the rudiments of a "polite education" in a school in Montreal, and at the age of 12 was sent to a private school in New York. His uncle, William Trotter Porter, saw to it that the boy had an opportunity in the next two years "to see life and people," and Paine always attached much value to that experience. Porter was editor of the *New York Spirit of the Times*, a pioneer sporting journal of considerable prestige, and his offices were a favorite rendezvous of the wits of the town and of famous actors and actresses. There, Paine said, he "drank in a love of fine things in conduct, in art, in literature, and in manners," which continued a joy to him throughout his life.

When 14 years old, Paine went to work as a clerk in the broadcloth factory of another uncle, the governor of Vermont. The latter was interested in a variety of enterprises, among them the promotion of the Vermont Central Railroad, of which he was president. On this line Paine went to work as rodman, developing in three years to such an extent that in 1848 he was ready for the assignment as division engineer on the Vermont and Canada that already has been mentioned. In the following years he was in charge of various railroad construction jobs in Canada, and supervised the building of docks at Montreal. Two railroad ventures in Wisconsin next retained him as chief engineer, but neither project got beyond the stage of grading the roadbed, because of the panic of 1857.

That panic had its effect on established roads as well as proposed ones, among them the Michigan Southern and Northern Indiana, which was popularly rechristened the "Miserably Slow and Nearly Insolvent." (This road, joining Detroit and Toledo with Chicago, is now a part of the New York Central system.) Paine became superintendent of the western division in 1858, and remained with the company—or its lineal successors—for 23 years. He was made chief engineer in 1864 and general superintendent in 1872. During this period he effected such improvements and economies that by 1876 the line was able to carry freight for 4 mills per ton-mile (maintenance and operating charges)—a low figure for the time.

Paine Gives Advice on Railroading

A distinctly unusual little book is *Elements of Railroading*, a volume of short essays by Paine reprinted in 1885 from the *Railroad Gazette*. Much of it is based, of course, on his experiences on the Michigan Southern. Scattered among more technical sections are discussions of human matters that suggest the reasons for his success as an executive: "Tact," "The Treatment of Trainmen," "Selection of Employés," "The Treatment of Passengers," and so forth. A few scattered quotations from this book will serve to illustrate some of these points, and incidentally, Paine's sense of humor and his attention to detail as well.

"Good men, who have become acquainted with their duties and who perform them faithfully, are the most important of all the appointments of a railroad. . . . The case of an erring employé should be tried on its own merits." If his fault arises from instantaneous forgetfulness, "dismissal is no remedy; the remedy has been applied by the accident; he will be a safer man ever after."

"It has resulted satisfactorily . . . to pay premiums to the engineers and firemen for the savings [in fuel] which they effect when compared with others . . . ; perhaps the spirit of emulation which is excited, and which makes honorable men more precious than money, may have even more effect than the hope to gain a pecuniary award."

"The condition of enginemen" and others of the train crew "is apt to be forlorn when they are away from home; some provision should be made for them to sleep and eat in comfort; and a sitting-room where they can pass the dreary hours of waiting . . . is necessary, if it is not preferred that they shall haunt the taverns."

"During the first half-century of railroading, the locomotive was regarded with some superstition, if not with awe, by those who ought to have become too familiar with it to be its dupe; it was the fashion to marry it to one man for life, or for so long as the pair could agree together; . . . he [alone] knew her secret springs of action, and when he was tired the locomotive stopped." But "the locomotive is a machine of iron and brass without sensibilities, and may be run day and night perpetually . . . until worn out or repairs are necessary. . . . The only way to accomplish this is by divorcing the engine from its runner, making it ready to pull a train whenever there is one to go."

"The passenger is a patron; he ought to be treated in such a

manner that his patronage will be continued .... Unfortunately, the employés of the transportation department . . . are not so much concerned with their obligations as they ought to be; it is their principal concern to 'put him through' .... To their eyes he is not a patron, but a parcel; if delivered at destination in an undamaged condition, the contract of the forwarder will be fulfilled."

"Waiting-rooms should not be scrimped in size nor in comfort; . . . the more attractive and convenient the rooms are, the oftener [the passengers] will go over the road. A fireplace in each waiting-room adds . . . to the cheerful appearance. . . . "

"Speed, safety and economy in operating expenses, all depend upon the character of the track. Every other department of the administration may be pinched or slighted with less evil results than that of the maintenance of way.... Every departure from the ideal condition [of track] is a certain cause of expense."

"There is nothing which so nearly approaches a 'fortuitous concourse of atoms' as an ordinary freight car truck. How it holds together, how it does duty so long, are questions which every master mechanic must reflect upon with amazement. ... Every master car-builder could improve it, ... [and] a careful accounting would certainly prove that it is better to pay more in first cost than to pay so much for constantly repeated small repairs, as is now necessary."

"The small obstacles to the prompt movement of freight . . . can only be discovered by the patient investigation of every complaint."

"Surveys should not be too much hurried. ... It seems frequently to be supposed that it is the instruments which perform the location, and not the understanding and judgment which direct them."

"The neophyte placed in charge of a division of track should be warned that the section foreman of common mold always begins a ditch at the upper end, ... and never opens the lower end of it ... until the trackmaster finds the ditch full of water.... It is, best, therefore, to give special directions about this, in each case, to begin with."

A rather discouraging episode followed Paine's years of work on the Michigan Southern. Between 1881 and 1884 he organized and carried through the building of the New York, West Shore, and Buffalo Railroad. Neither pains nor money was spared to make it as efficient and economical a carrier as possible. Paine believed enthusiastically in the enterprise and invested heavily in it. But it was an expensive line, and competed at nearly every station along its 425 miles with the Hudson River, the Erie Canal, and the New York Central and Hudson River Railroad. Within a few months of its opening it was in bankruptcy.

Paine found himself at 54 with his lifetime's savings gone and his health impaired. He needed rest and recreation to build himself up, but was unable to afford it. So with characteristic optimism and boldness, he borrowed money and treated himself to a year's vacation in Europe before going back to work. The cure was successful; until the day of his death he never suffered another illness.

On his return he served for a time as general superintendent of the New York, Pennsylvania and Ohio Railroad (originally the Atlantic and Great Western, and later leased to the Erie). He was also second vice-president of the Erie for a few months, and later (after 1890) the general manager of an Erie subsidiary, the Union Steamboat Line.

Once while engineer of the Michigan Southern, Paine interviewed a young inventor, then little more than a lad, who had designed an improved type of frog. Paine ordered a sample, found the product satisfactory, and from time to time placed additional orders. The young man had another project in mind—the development of a practicable form of continuous train brake. Paine discussed it with him and encouraged him, and the outcome of these conversations was the beginning of a lifelong friendship that proved of value to both men.

The young inventor was George Westinghouse. In 1883 he became interested in the uses of natural gas, which was already being brought to Pittsburgh by several pioneer organizations. The method of transmitting it was crude, and resulted in a number of serious accidents. Within two years Westinghouse had applied for more than 30 patents on improved apparatus, and in 1884 he organized a company which, with good financial backing and the advantage of his inventions, soon outran its competitors, acquired their properties by purchase, and provided Pittsburgh and vicinity with an integrated system of gas supply. Despite its location, this organization was known as the Philadelphia Company.

Paine came into the picture in 1885 as vice-president and general manager of the board of direction. During the next six years he was in active executive charge of the company, and had a part in the management of a number of other Westinghouse companies as well.

In 1891 he began a consulting practice in New York, which continued until he became general manager of the Panama Railroad Company in 1899. This was his last professional engagement. It ended in 1905, with the purchase of the railroad by the federal government and its transfer to the Canal Commission. After a year of retirement, Paine died in Tenafly, N.J., July 4, 1906.

A fine tribute was paid him in the obituary published in the *Railroad Gazette* the following week: "He was a learned man with fine literary tastes and capacity for expression; a sound engineer of good judgment; and a safe railroad officer who enforced discipline and inspired loyalty. ... His monument is a correct and blameless life in positions of great responsibility, and the men he has encouraged, advised, and trained in uprightness and thoroughness."

WE'RE GOING PLACES!

WHERE? To the Spring Meeting American Society of Civil Engineers – Plaza Hotel in San Antonio.

WHY? To see – to hear – to learn the latest developments in Engineering practice.
To see Construction projects of unusual interest.
To meet and swap notes with other Engineers from all parts of the Country.
To loosen up and enjoy life in a big way.

WHEN? APRIL 21, 22, 1937.

WHAT? The biggest Meeting of Civil Engineers ever held in the Southwest.

WHO will be there? You and your wife and all the other "up and coming" Civil Engineers and their wives who appreciate the opportunities and pleasures afforded by a National Meeting of the A. S. C. E.

HOW to get there! By plane, by train, by bus, by trailer. Hitchhike if you must, but BE THERE.
Be SURE to arrive by 9:30 P. M., April 20, for the big BOHEMIAN CLUB prelim.

The Local Arrangement Committee requests that hotel reservations be made directly and at once. The Plaza Hotel will be meeting headquarters.

TEXAS SECTION ANNOUNCES THE SPRING MEETING

This Handbill, Inserted in a Recent Issue of the "Texas Engineer," Went to Every Society Member in the State, and to Chambers of Commerce, County Judges, and All Engineers of the State Highway Department. It Illustrates the Typical Qualities of Enthusiasm and Energy That Promise Well for a Successful San Antonio Meeting

Publication on Fees Reprinted

FOR THE convenience of members who have continuous use for this information, a booklet covering "Recommendations for Determining Fees to Be Allowed for Professional Engineering Services on Federal and Federal Aid Projects" has been reprinted by the Society. Originally it appeared in May 1935 and has been used continually since that time. The regular blue cover characterizing Society separates has been used. This reprint, which is numbered 1937–1, is available at Headquarters at a cost of 20 cents.

Crowell Is New Office Manager

FREDERICK S. CROWELL has been chosen as office manager of the Society, to fill the vacancy created by the retirement of Miss Eleanor H. Frick. He comes to his new post with 18 years of experience with the American Society of Mechanical Engineers, including several years as office manager and purchasing agent.

FREDERICK S. CROWELL, NEW OFFICE MANAGER

Mr. Crowell was born and educated in Newport, R.I. On the outbreak of the World War he interrupted a course in business management to enlist in the U. S. Navy, and afterward he was for some time with the New York State Reconstruction Commission. His broad background of service with another of the Founder Societies since then, coupled with his energetic spirit and friendly personality, well qualifies him for this post. His new duties began February 15.

Memoirs of Deceased Members

The following memoirs of deceased members are available, in limited numbers, to any members who wish to address a request for them to the Secretary of the Society:

Onward Bates	1850–1936
Albert Farwell Bemis	1870–1936
Albin Hermann Beyer	1880–1936
Robert Carr Churchill	1890–1936
Otto Rae Elwell	1890–1935
Theodore Henry Hinchman	1869–1936
Edward Sherman Jackson	1865–1935
Ralph Long Kell	1881–1936
Carl Gustaf Emil Larsson	1864–1936
Frank Howard Neff	1865–1936
Milnor Peck Paret	1857–1936
Marshall Hudson Reese	1904–1936
Frederick Edward Schall	1857–1936
Charles Eugene Sudler	1876–1936
Edward Ralph Taylor	1898–1935
Ray Benedict West	1882–1936

Year Book to Be Issued in April

THE 1937 Year Book will be mailed to the membership on the usual date, April 15, as Part 2 of PROCEEDINGS for that month.

Changes of employment and location have been so numerous during the past twelve months that it has been an especially difficult task this year to get the data in form for publication. Every page has been completely reset, and all changes of which Headquarters had notice by March 1 have been incorporated.

As usual, the Year Book contains much valuable material in addition to the membership list. It explains, for example, the operation of the Engineering Employment Service; the rules governing the award of prizes that the Society administers alone or in conjunction with other organizations; the service provided by the Engineering Societies Library to non-resident members; and the regulations for preparing and presenting papers. In short, most of the questions that arise in connection with a member's relation to the Society are answered by the Year Book.

Committee Set-Up for Frisco Section

THE SAN FRANCISCO Section has recently revised its committee set-up, in order to give each committee a distinct function and to eliminate all overlapping of activities. This new organization has several features that other Local Sections may find valuable. The committees and their functions are:

Program—To develop programs for regular and special meetings.

Membership—To endeavor to get all members of the Society in the vicinity of San Francisco to join the Section and to endeavor to get qualified engineers not members of the Society to apply for membership.

Reception—To welcome members and visitors at the door at each meeting. To introduce visitors and promote fellowship. To record individual attendance.

Professional Conduct—To promote ethical thinking in the relationship of mem ber to member, member to client, and member to employee.

Public Relations—To promote member interest in community affairs and individual activity in acquainting the public as to the activities, aims, and objects of civil engineers. To secure favorable publicity for the profession.

Legislative—To observe and act on any engineering legislation that may affect the public and the member welfare.

Annual Fellowship Party—To make arrangements for and conduct an annual fellowship party to which ladies are invited.

Excursion Inspection Trip—To make arrangements for and conduct inspection trips to engineering projects or manufacturing plants.

Building Code—A special committee of several years' standing, continued to complete its work.

Sanitary—To promote the welfare of members interested especially in sanitary engineering.

Surveys and Maps—To promote the securing and filing of surveys and maps.

National Convention 1939—To prepare for a meeting of the Society in San Francisco during the Exposition year.

In addition, a representative of the Section has been named to the Engineering Societies Employment Service in San Francisco, and three representatives to the San Francisco Engineering Council.

Many of the committeemen are Associate Members and Juniors; two of the committees were appointed entirely from the latter group. The president of the Section makes it a point to meet with each of the committees to stimulate interest and activity.

Seven More Junior Correspondents

THIRTY-ONE Local Sections have now appointed one or more Juniors to serve as correspondents for CIVIL ENGINEERING. Additions to the list since it was published in the December 1936 issue include:

Dayton	E. F. Stansberry
Illinois	Clarence L. Waterbury
Ithaca	Harold Hawkins
Kansas State	M. H. Davison
Nashville	W. H. Dyer
Northeastern	F. S. Farquhar
San Francisco	Frederick Weiss

In January and February some 40 items suitable for use in CIVIL ENGINEERING were received from the junior correspondents. About half of these were reports of Local Section meetings, and the remainder were "News of Engineers" notes. It is expected that longer "Items of Interest," for which definite authorship credit can be given, will also be supplied from time to time from the same source.

It is gratifying to thus note once again the definite service to the Society being performed by the 45 Junior correspondents. Although it is not feasible to acknowledge publicly the source of each item as it appears, this general tribute will serve to record the appreciation of the Society for their helpfulness.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

Construction and Employment

According to the F. W. Dodge Corporation, publicly financed construction for the 37 eastern states in 1936 was $1,334,000,000 while privately financed construction for the same area totaled $1,341,000,000, both substantial increases over 1935. Last year was the first year since 1931 that private construction exceeded public construction in the United States.

Unemployment figures for the last three months have shown slight decrease according to several of the better-known sources of information. At the close of 1936, the American Federation of Labor reported that more than 2,000,000 people had found work in 1936, but they also reported that the unemployed still numbered almost 9,000,000. In spite of the gains in employment, current reports indicate that the relief rolls are only slightly affected by them. Our foremost economic problem, therefore, is how to find work for the unemployed men and women of the United States. At the low point of the depression, 15,600,000 were unemployed; after 3 1/2 years of recovery approximately 8,900,000 have been reemployed, and still 9,000,000 men and women are reported to be unable to find sufficient work in industry or agriculture to sustain themselves.

Industry legislation designed to effectuate the recommendations of the joint management-labor Council for Industrial Progress or to revive something like the NRA is still nebulous but is receiving much consideration. Among the more favored objectives are federal aid to small business enterprises; a permanent economic advisory commission; establishment by law of maximum hours of work and minimum wages in industry; abolition of child labor; and prevention of unfair methods of competition. Another proposal would enlarge the Federal Trade Commission to nine members so constituted as to provide equal representation of the public interest, management, and labor in the same administrative agency.

Status of PWA Work

The Public Works Administration now officially claims to have created 2 1/2 times more work in private industries supplying building materials than in the building trades and construction labor on the site, and this is supported by the results of a two-year study by the Bureau of Labor Statistics. These statistics do not take into consideration the "secondary indirect" work created by the Public Works Administration. Such employment came from the manufacture of clothing, food, and other consumers' goods required by those people employed on construction sites or in material production.

The Bureau of Public Roads reports that the highway program to relieve unemployment had resulted in the construction of 38,220 miles of road at the close of the last fiscal year at a cost of $636,622,561, of which $571,276,033 was paid by the federal government with funds apportioned to all states.

The Secretary of Agriculture is reported to have apportioned $200,000,000 on December 29, 1936, to the various states for the improvement of the federal aid highway system, the improvement of secondary or farm-to-market roads, and the elimination of hazards at grade crossings. On the same date, the Secretary announced the apportionment of $2,500,000 for the construction of main roads through unappropriated or unreserved public lands, non-taxable Indian lands, or other federal reservations other than national forests, and extended the apportionment through the fiscal year 1938. In addition to the initial $200,000,000 appropriation of emergency funds for grade-crossing elimination, the Secretary announced on February 12, 1937, that the states may share in a $50,000,000 federal fund authorized by an Act of Congress on June 16, 1936, for an extension of grade-crossing elimination work.

The Civilian Conservation Corps reported in February that the "CCC boys" had planted an average of more than one million young trees and seedlings each working day since the Corps was launched on April 5, 1933. Total plantings for reforestation, erosion control, wild-life cover, and other purposes aggregated 1,035,000,000 trees for the period ending January 1, 1937. It is interesting to note in this connection that the planting of seedlings prior to 1933, including federal, state, local, industrial, and private reforestation, did not exceed a yearly average of 135,000,000 trees.

Engineers' Service Effective in Flooded Areas

U. S. Public Health Service's reports made during the recent flood period disclosed that over 200 sanitary engineers were assigned from federal service to the Ohio and Mississippi flood regions, and 40 additional engineers were detailed by the state health departments in Kentucky, Ohio, Illinois, and Indiana. These sanitary engineers and medical officers advised and assisted 94 cities and towns with a combined population of 1,401,756 people. They helped provide emergency supplies of drinking water and assisted with the restoration of sanitary water-supply service in most of these cities. It is to be regretted that the personal sacrifice and contributions made by sanitary engineers and other members of the engineering profession in this emergency has not received more publicity.

The National Resources Committee has released the minutes of a joint meeting of its Water Resources Committee with the Committee on National Water Policy of the American Society of Civil Engineers, the American Water Works Association, the Conference of State Sanitary Engineers, and the American Engineering Council, held in the Interior Building on September 22, 1936. A limited number of copies may be obtained from the Publications Section, National Resources Committee, Interior Building, Washington, D.C. Council cannot afford to make general distribution of the National Resources Committee's report on Public Works Planning issued in December 1936, but engineers who are interested in long-range public works programs may obtain a copy and study the background for the $5,000,000 public works plan submitted to Congress by President Roosevelt as a bulwark against a new depression.

The program for expediting the topographic mapping of the United States, recommended by Secretary Ickes, involves a 20-year program and the expenditure of $100,000,000. This would give the Geological Survey $4,000,000 for topographic surveys and maps, and the Coast and Geodetic Survey $1,000,000 for first- and second-order control surveys in 1938 under such items as the directors of the Surveys may designate. Council's staff and mapping committee have laid the increasing need for adequate maps and surveys before the President and many public officials and lawmakers in a position to appreciate the merits of the case.

An official statement of the Social Security Board says that a total of 23,647,461 people now have applications for social security accounts on file in every state and 75 principal cities of the United States. Of equal interest is a recent report stating that almost 1,500,000 needy men, women, and children received public assistance under state programs established in accordance with the Social Security Act in the first 11 months following the date on which it became effective. All but seven states are participating in one or more of the public-assistance programs set up by the Social Security Act and using both federal and state funds.

Engineers' Embassy Service

In the future, the Engineers' Embassy Service is to be a staff function of Council, to transmit engineering points of view and resolutions to public bodies and the executive and administrative heads of the several arms of government service. It will also provide member organizations with an information service in Washington and advise members of member organizations who visit Washington regarding contacts among government agencies.

Washington, D.C.
March 8, 1937

SPRING MEETING OF THE SOCIETY, April 21–24, 1937, in San Antonio, Tex.

Preview of Proceedings

By Harold T. Larsen, *Editor*

To date five papers and a Division Committee report have been prepared for publication in the April and May issues of "Proceedings." Because of the distance from Society Headquarters to some of the authors, and because of complicated line drawings still to be prepared, it is anticipated that some of these papers may not be ready in time for the April number of "Proceedings." It is somewhat like betting on the races to foretell which of them will come in first.

The Passage of Turbid Water Through Lake Mead

A paper of potentially far-reaching importance on the subject of silt will appear in the April issue of Proceedings under the title, "The Passage of Turbid Water Through Lake Mead," by Nathan C. Grover, M. Am. Soc. C.E., and Charles S. Howard, Esq. The general subject of silt transportation and deposition is of unusual interest at the present time. The paper by Messrs. Grover and Howard, which is quite brief, begins with a summary of the literature in this field. Then follows a discussion of the phenomenon of the stream of turbid water flowing through a reservoir of clear water without mixing with it—that is, it flows through a reservoir of great length such as Lake Mead, formed by Boulder Dam, and is discharged at the dam with its fundamental characteristics unchanged. The authors suggest that a study of this phenomenon may be of value in connection with the great unsolved problems pertaining to the gradual loss of capacity caused by the deposition of silt in reservoirs. They have organized their data in such a manner as to encourage the presentation of new findings calculated to bring into sharper focus before the profession the phenomenon of the unmixed flow of a turbid water through a clear water, the conditions essential to such flow, and the possible practical aspects.

Soil Reactions in Relation to Foundations on Piles

The subject of the bearing capacity of pile foundations always raises a great number of moot questions. This entire field has once more been "laid wide open" by R. M. Miller, M. Am. Soc. C.E., in a forthcoming paper entitled "Soil Reactions in Relation to Foundations on Piles." Mr. Miller's thesis is founded upon observations in the field rather than upon theoretical investigation. One may search the entire paper without finding a single equation.

According to Mr. Miller, the function of skin friction is to transmit part of the load on a pile through the adjacent soil to the firmer soils beneath the point of the pile. If the pile does not extend through intervening soft strata—that is, if it has no point resistance—skin friction is negligible and the usefulness of the pile is questionable. A cardinal purpose of the paper is to impress the designer of pile foundations with the importance of investigating the soil by suitable borings before specifying the length and type of piles and the manner of driving them. Twenty-four examples are presented to support the conclusion.

Hydraulic Tests on the Spillway of Madden Dam

The literature on the flow of water over dams and weirs is considerably advanced by test observations on the spillway of Madden Dam in the Panama Canal Zone, as presented in a forthcoming paper by Richard R. Randolph, Jr. The consensus of opinion among experts who examined the manuscript is that Mr. Randolph has done especially good work in condensing the material into a concise paper, free from unnecessary mathematical detail. The paper is a straightforward and thoroughly technical discussion of model tests and their confirmation on the prototype, these two subjects constituting the natural division between Part 1 and Part 2. The problem discussed is a common one, but the size of the structure made this particular example unusual and the solution suggested is almost unique.

Preliminary to the construction of Madden Dam during the summer and autumn of 1931, a model was constructed at the hydraulic laboratory of the Colorado Agricultural College at Fort Collins, Colo. A model of the spillway was built on a scale of 1:72, or 1 in. on the model equal to 6 ft on the prototype. Many experiments were made with a level apron, using impact sills and baffles, before this form was varied by inclining the apron from the point at which it left the bucket in order to control the hydraulic jump for dissipation of the overflow. The downstream slope and elevation for the spillway apron were determined in such a manner as to fix the location of the hydraulic jump on the concrete apron for all flows. As a result of these model studies, the prototype was constructed with an apron slope of 1:4.3, and piezometers were placed in the finished structure at relatively the same places as in the model. The resulting comparative readings will be

View of Spillway Flow Over Madden Dam

found extremely interesting to designers in this field. The accompanying photograph is a view of a spillway flow of 31,800 cu ft per sec over Madden Dam. The structure consists of four 100-ft drum gates. The opening can be closed progressively by raising the gates in unison.

Practical Use of Horizontal Geodetic Control

Civil engineers and surveyors, who, through lack of constant practice, tend to avoid the principles of geodetic surveying in every-day experience, will find much stimulating information in a paper entitled "Practical Use of Horizontal Geodetic Control," by R. C. Sheldon, Assoc. M. Am. Soc. C.E. Since a large number of political subdivisions of the United States have already adopted the system of rectanglular coordinates, it is expected that this paper, advocating a simplified system of geodetic control, will draw considerable discussion. An introduction to the paper contains suggestions to the engineer, for starting to use this control. In the main part of the paper there follow: (1) a description of the origin and use of such a system in the Panama Canal Zone; (2) an analysis of the errors developed by using the system in the Canal Zone; and (3) a similar analysis of the errors developed by using the same system near the 40th parallel of latitude. To aid in the task of simplifying this method for the practical surveyor, Mr. Sheldon introduces several short tables for examples and gives ample bibliographical references for those who are interested in following the subject further. In his conclusion, he states his opinion that plane surveying is out of date and that any system of surveying which does not fit in with the positions of the national geodetic net is doomed to eventual failure.

Pressures Beneath a Spread Foundation

A highly valuable addition to the store of knowledge on stress analysis in earth masses characterizes the forthcoming paper by D. P. Krynine, M. Am. Soc. C.E., entitled "Pressures Beneath a Spread Foundation." More particularly, it contains various facts which are considered essential to foundation design and construction. The work is divided into two parts. Part 1 contains a description of a suggested method of determining pressure under both uniformly and non-uniformly loaded foundations under the assumption that all acting unit loads are finite. Part 2 concerns the relative rigidity of spread footings and earth masses, including the interaction between the two. In connection with Part 1, Professor Krynine suggests a graphical process which he terms the "reduced area method," using the conception of the "concentration factor" introduced to soil mechanics about 1934. This graphi-

cal method is based on the subdivision of the loaded area into circular rings and not into rectangles, as was proposed in 1928 by Messrs. Kogler and Scheidig—to whom the author gives credit. The scope and purpose of the paper are fully summarized in the 12 items of the conclusion, and supplementary information, chiefly analytical in character, is contained in three appendices.

WATER SUPPLY ENGINEERING

The first annual report of the Committee of the Sanitary Engineering Division on Water Supply Engineering, which was published in the March 1934 issue of PROCEEDINGS, covers the status of this subject for several years prior to that time. The 1934 report was published in PROCEEDINGS for March 1935, and the committee report for 1935 will appear in the forthcoming number of PROCEEDINGS. The new report lists, in brief outline, the most important construction projects now under way in Birmingham, Ala.; Southern California; Denver, Colo.; Milwaukee, Wis.; Cincinnati, Ohio; New York City; Detroit, Mich.; Fort Smith, Ark.; Buffalo, N.Y.; and Little Rock, Ark. The effect of floods and other accidents on water-supply plants throughout the country is described in some detail. The report then ends with brief comments on progress and innovation in the design and construction of dams, pipelines, and pumps.

Correspondence from the membership on the contents of this report will be transmitted directly to the chairman for his information.

News of Local Sections

BUFFALO SECTION

The Buffalo Section held its regular monthly meeting at the Buffalo Athletic Club on February 9, 1937. There were 42 present to hear W. P. Creager, consulting engineer of Buffalo, speak on the mechanics of soils. Mr. Creager illustrated his talk with many blackboard examples of mathematical formulas and his remarks proved of interest to all present.

CENTRAL OHIO SECTION

A joint meeting of the Central Ohio Section and the Columbus Engineers' Club took place at the Chittenden Hotel in Columbus on February 15. The feature of the occasion was an interesting talk by C. F. Goodrich, chief engineer of the American Bridge Company, whose topic was the San Francisco–Oakland Bay Bridge. The talk was illustrated with lantern slides and sound motion pictures. There were about 400 present.

CINCINNATI SECTION

The list of new officers for the Cincinnati Section is as follows: Herbert H. Schroth, president; Warren W. Parks, vice-president; and William W. Carlton, secretary-treasurer. They will take office in April at the expiration of the fiscal year.

CLEVELAND SECTION

The regular monthly luncheon meeting of the Cleveland Section was held on March 9 at the Cleveland Chamber of Commerce. Progress of the committee on professional practice was reported by Wendell Brown and F. C. Tolles. Then A. F. Blaser, president of the Section, introduced A. A. Markee and F. D. Smith, of the Linde Air Products Company, who gave interesting illustrated talks on cross-country, welded pipe lines.

DAYTON SECTION

There were 28 present at the regular luncheon meeting of the Dayton Section, which was held at the Engineers' Club on February 15. This number included five members of the University of Dayton Student Chapter. An interesting talk on occurrences in the Ohio Valley at Cincinnati during the recent floods was given by Edgar Dow Gilman, Director of Public Utilities for Cincinnati. An enthusiastic discussion followed.

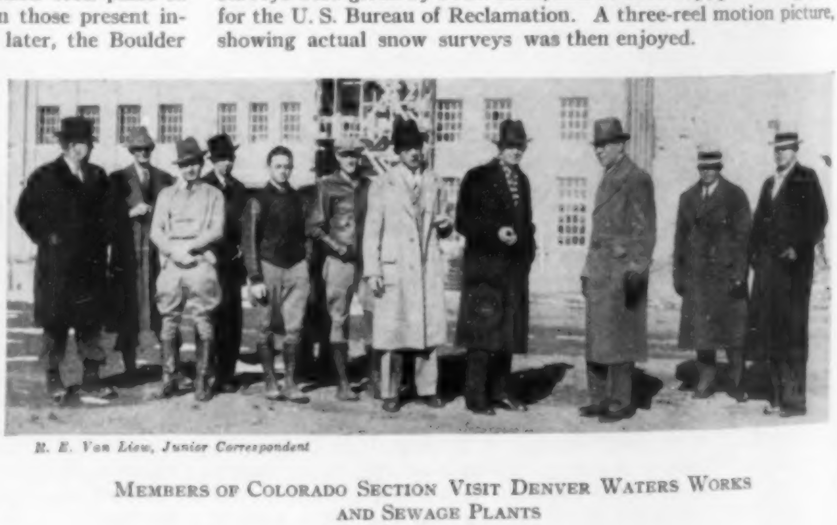
DULUTH SECTION

On December 21 the regular monthly meeting of the Duluth Section took place, with 13 present. The feature of the occasion was a talk on rural electrification in the vicinity of Duluth, which was given by C. H. Tibbetts, of the Minnesota Power and Light Company. The annual election of officers took place at the meeting held on January 18. The list of these is as follows: George W. Deibler, president; Ralph M. Palmer, first vice-president; A. B. Jones, second vice-president; William E. Hawley, secretary; and John Carson, treasurer. The 12 members present then heard a talk by John Darling, who reminisced concerning his engineering experiences with the U. S. Engineers in the early development of Duluth Harbor and the Upper Mississippi. At the meeting held on February 15 A. B. Horwitz, of the Duluth City Planning Department, gave a résumé of city planning and described the introduction of this work in Duluth in 1922.

COLORADO SECTION

The February meeting of the Colorado Section took place in Boulder on the 13th. Early in the afternoon those present inspected the Valmont steam power plant and, later, the Boulder Canyon hydroelectric plant. Dinner at Blanchard's Lodge was followed by the regular business meeting and several talks. These were given by A. H. Heitzler, R. F. Throne, and W. D. Hardaway, engineers connected with the Public Service Company. There were 50 present. On February 28 another field trip was enjoyed. On this occasion 21 members of the Section visited Denver's new water-works project and sewage plant.

There were 75 present at a meeting of the Junior Association of the Colorado Section, which was held on January 25. The program for the evening, which was in charge of C. C. McNamara, consisted of a talk by C. A. Hieland, of the Colorado School of Mines. Mr. Hieland's talk, which dealt with the application of the principles of geophysics to engineering, was followed by a general discussion. On February 24 another meeting of the Junior Association was held, with 55 present. Talks on snow surveys were given by F. R. Cline, and O. C. Reedy, junior engineer for the U. S. Bureau of Reclamation. A three-reel motion picture, showing actual snow surveys was then enjoyed.



R. E. Van Liew, Junior Correspondent

MEMBERS OF COLORADO SECTION VISIT DENVER WATERS WORKS AND SEWAGE PLANTS

Georgia Section

An interesting talk and demonstration in connection with the science of communication was the feature of the luncheon meeting of the Georgia Section, which was held at the Atlanta Athletic Club on January 11. This talk was given by G. F. Goode, of the Southern Bell Telephone Company. There were 26 members and guests present. Another luncheon meeting of the Section took place on February 8, with 23 in attendance. Following a business session, a talk was given by E. V. Camp, whose subject was highway guards. This talk was illustrated by motion pictures of experiments made by the Georgia State Highway Department in their testing of various types of guards.

Indiana Section

On February 16 the Indiana Section followed its annual custom of joining the Indiana Engineering Society and local branches of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers in holding an all-day meeting. During the morning session plans for reorganizing the Indiana Engineering Society as a state engineering council were discussed and adopted. Following an engineers' luncheon, the annual business meeting of the Section took place, and the following officers were elected: Charles Brossman, president; Charles A. Ellis, vice-president; and Fred F. Kellam, secretary-treasurer. Later in the afternoon there was a joint technical session, at which there was a discussion of "The Engineer's Place in Community Development." The speakers on this program were Lawrence V. Sheridan, consultant to the Indiana State Planning Board; M. R. Keefe, chief engineer of the Indiana State Highway Commission; and David E. Ross, of the board of trustees of Purdue University. The speaker at the annual dinner was James H. Herron, president of the American Society of Mechanical Engineers.

Iowa Section

There were 75 present at the regular meeting of the Iowa Section, which was held in Des Moines on March 2. Impressions of the Annual Meeting of the Society were described by F. M. Dawson, J. S. Dodds, A. H. Fuller, H. J. Gilkey, E. L. Waterman, and H. E. Wessman. Announcement was then made of the Ohio Section awards of junior membership in the Society and the two recipients responded to the presentations with brief talks. The feature of the evening was a paper on the highway safety problem, which was given by R. W. Crum, director of the Highway Research Board, Washington, D.C. Mr. Crum was welcomed as first secretary and former president of the Section, who had "come home" to speak as a nationally known authority on highway problems.

Ithaca Section

About 500 members and guests of the Ithaca Section met in Baker Hall on the campus of Cornell University on March 3 to hear L. S. Moisseiff, consulting engineer of New York City, speak on the topic, "The San Francisco Bridges." Mr. Moisseiff stressed the struggle involved in the planning and building of such structures. Preceding the meeting, 35 members of the Section enjoyed a dinner in Willard Straight Hall.

Kansas State Section

The eighteenth annual meeting of the Kansas State Section took the form of a luncheon held at the Hotel Kansan in Topeka on February 10. During the business session the following officers for 1937 were elected: Ira E. Taylor, president; William E. Baldry, vice-president; and Frederick W. Epps, secretary-treasurer. Retiring president, Frank A. Russell, who was in charge of the meeting, gave a brief résumé of Section activities and accomplishments during the past year. There was no technical program, as most of those present were planning to attend sessions of the Kansas Engineering Society, which was holding its annual convention in Topeka at that time.

Los Angeles Section

The February meeting of the Los Angeles Section was held at the University Club on the 10th. Louis C. Hill, President of the Society, was present and gave a short résumé of the Annual Meeting, describing his installation into the presidency. Interesting talks were given by R. F. Brown, assistant superintendent of sewer maintenance of the city of Los Angeles, and D. Arnold Lane, underground engineer of the Los Angeles Bureau of Water Works and Supply. Mr. Brown described an inspection trip through the city's outfall sewer that he recently made in a special boat, while Mr. Lane brought out the fact that ground water constitutes a safety factor in the event of any interruption of aqueduct service and stressed the necessity of maintaining an adequate level in hidden reservoirs.

A meeting of the Junior Forum of the Los Angeles Section preceded the regular Section meeting. The speaker at this session was Walter Dickey, who gave an interesting and humorous presentation of his experiences as engineer in railroad and plant location and jungle-clearance work in British Honduras.

Metropolitan Section

A series of related talks on the subject of new developments in building materials was given at a meeting of the Metropolitan Section, which took place in the Engineering Societies Building in New York City on February 17. The symposium was introduced by J. P. H. Perry, vice-president of the Turner Construction Company and former president of the Section. The other speakers on the program were A. E. Marshall, of the Corning Glass Works, who discussed the future of fibrous glass in the building field; H. R. Berlin, of the Johns-Manville Company, whose topic was "The March of Time in Partitions"; and William Hogenson, of the Republic Steel Corporation, who concluded the presentation with a talk on the application of stainless steels and enameled sheets to building construction. Mr. Hogenson's talk was illustrated by a sound motion picture entitled "The Magic Metal of 10,000 Uses." There were about 450 present.

Milwaukee Section

Members of the Milwaukee Section heard W. H. Holcombe, of the Corps of Engineers U. S. Army, address a dinner meeting, which took place at the Republican Hotel on February 18. Colonel Holcombe, who served for several years as district engineer at New Orleans during the construction of the present flood-control system for the Lower Mississippi, gave an interesting and descriptive talk on the levee and floodway system. He pointed out that the volume of water in natural storage along the lower river during major floods is about equal to the combined volume of Lakes Erie and Ontario, so the control of Mississippi floods by means of reservoirs on the headwaters is entirely impractical. There were 52 present.

Philadelphia Section

The Philadelphia Section had a festive evening on February 20, the occasion of the twelfth annual social meeting. Dinner was enlivened by a quantity of colored balloons and favors and the singing of favorite songs. A program of entertainment, which had been arranged by Lyle Jenne, then followed. There were juggling acts, a tenor with a guitar, humorous recitations, tap dancing, and a fortune teller. Through the courtesy of the Philadelphia Electric Company, races were run on a special electric track, and the proceeds from the sale of betting material were turned over to the Red Cross. Dancing and a social hour concluded the evening. There were 139 present.

Portland (Ore.) Section

A meeting of the Portland (Ore.) Section took place at the University Club on November 27, 1936. After a business session the speaker of the evening, Charles Derleth, Jr., was introduced. Professor Derleth, who is dean of the college of engineering at the University of California and a member of the board of consulting engineers for both the San Francisco–Oakland Bay Bridge and the Golden Gate Bridge, gave an interesting illustrated lecture on these two important projects. The attendance numbered 105. Election of officers for 1937 was a feature of the annual meeting of the Section, held at the Benson Hotel on January 8. The list of these officers is as follows: C. H. Canfield, president; C. A. Mockmore, first vice-president; R. B. Wright, second vice-president; and K. L. Coltrin, secretary-treasurer. The 94 members and guests present then heard Leith F. Abbott, advertising manager of the Southern Pacific Company, give an illustrated talk on Mexico.

Sacramento Section

During February the Sacramento Section continued its practice of having weekly luncheon meetings. On February 2 there were 31 present to hear Nils Aanonsen, supervisor of the division of operation of the Sacramento WPA, give a résumé of past and present unemployment problems in Europe and this country. The speaker at the meeting held on February 9 was W. F. Meyer, professor of astronomy at the University of California, whose topic was "Recent Achievements in Astronomy." There were 73 present. The 80 members and guests in attendance at the meeting held on February 16 enjoyed an all-color motion picture of California highways, which was shown by J. J. McGinness, of the California State Division of Highways. The meeting held on February 23 was devoted to a consideration of pending legislation affecting the engineering profession. There were 35 present.

San Francisco Section

A joint meeting of the San Francisco Section and local branches the other Founder Societies was held on January 28. On this occasion the various phases of corrosion were discussed by Colin G. Fink, W. R. Schneider, and others. The attendance numbered 550. On February 16 the regular meeting of the Section took place, with 190 members and guests present. "The Engineer of the Past, Present, and Future" was the topic of a talk given by Charles Derleth, Jr., dean of the college of engineering of the University of California.

South Carolina

The South Carolina Section of the Society held two technical meetings during 1936. On January 9 a joint session with the South Carolina Society of Engineers took place at Columbia. The speakers were Lawrence W. Pollard, director of the South Carolina Railroad Commission, and Prof. S. B. Earle and W. H. Mills. The second meeting was a two-day session, which was held at Myrtle Beach, S.C., on July 10 and 11. On this occasion addresses were given by Harry Slattery, personal assistant to the Secretary of the Interior, and Prof. Theodore S. Johnson, Lawrence W. Pinckney, and Harry Tubas.

Spokane Section

On February 12 the Spokane Section held a meeting at the Davenport Hotel. A report on the Annual Meeting of the Society was given by Director Ivan C. Crawford, who spoke on several points of interest to the Section, including the new membership committee report form.

A lively round-table discussion of the topic, "Soils as Foundation Materials," was the principal feature of a meeting of the Spokane Section held at the Davenport Hotel on January 8. This discussion was led by W. L. Malony. During the business session it was decided to offer two annual prizes of junior membership in the Society for the best papers written by civil engineering students graduating from the University of Idaho and the State College of Washington.

St. Louis Section

The regular monthly luncheon meeting of the St. Louis Section took place at the Mayfair Hotel on March 1. The feature of the occasion was a talk by Ernest R. Swanson, of the Aerial Surveying Section of the U. S. Engineer Department, who explained the technique of aerial surveying for contour and other mapping. Mr. Swanson described the machines used at present to perform the exceedingly delicate operation of drawing these contours. He is the inventor of a simplified and portable machine—the aerostereograph—which not only does this work but will permit making two-color stereoscopic photographic prints.

Virginia Section

Members of the Virginia Section met for their annual meeting at the Jefferson Hotel in Richmond, Va., on February 19. In the afternoon ballots for 1937 officers were canvassed, with the following results: C. W. Ogden, president; W. T. Howe, C. W. Johns, and R. W. B. Hart, vice-presidents; and P. A. Rice, secretary-treasurer. Four interesting papers were then presented by D. B. Fugate, inspector for the Virginia State Department of Highways; S. L. Williamson, city engineer of Charlottesville, Va.; F. N. Hibbard, of the U. S. Weather Bureau; and R. B. Preston, chairman of the Hampton Roads Sewage Disposal Commission. After an informal dinner in the evening W. D. Tyler, retiring president of the Section, introduced Lyle F. Bellinger, Herman Stabler, and George T. Seabury, respectively Vice-President, Director, and Secretary of the Society. These three officers discussed Society affairs briefly. The committee on arrangements for this highly successful affair consisted of R. S. Royer, chairman, and Fontaine Jones and A. W. Harman.

Student Chapter Notes

Lewis Institute

Members of the Lewis Institute Student Chapter recently enjoyed the Society's illustrated lecture on Wheeler Dam, which was presented by two members of the Chapter. The Junior Branch of the Illinois Section of the Society was also discussed. There were 20 present.

Pennsylvania Military College

The president of the Pennsylvania Military College Student Chapter presented the Society's illustrated lecture on the George Washington Bridge at a meeting of the Chapter held on February 18. This was followed by a general discussion, in which some interesting sidelights on the construction of the bridge and the personnel in charge were given by Professor De Moyer. The attendance numbered 24.

South Dakota State School of Mines

On February 5 a well-attended meeting of the South Dakota State School of Mines Student Chapter took place, with most of the faculty as well as the Chapter members present. The feature of the occasion was the showing of the Society's illustrated lecture on the San Francisco–Oakland Bay Bridge. There was also a brief business discussion.

University of Arizona

The Society's illustrated lecture on Wheeler Dam was shown at the regular monthly dinner meeting of the University of Arizona Student Chapter, held in the University Commons on February 10. Prior to the showing of the slides, the members enjoyed an interesting talk by W. H. Howe, of the Tucson Gas and Power Company, on the subject of "Inventory and Evaluation of Public Utilities."

University of Arkansas

At the final meeting of the fall term the University of Arkansas Student Chapter elected new officers for the spring semester. Then Larry Kelley, member of the Chapter, gave a paper on "Cheap Levees to Control Lake Okeechobee," in which he discussed tidal control. The concluding paper was presented by Robert Nienstedt, another Chapter member, whose topic was the application of aerial photography to engineering.

University of Maryland

At a meeting of the University of Maryland Student Chapter, held on January 13, several business matters were discussed, including the forthcoming Student Chapter conference, to be held at Johns Hopkins University in April, and the Chapter's year book. Then Edward Gibbs, senior-class member of the Chapter, presented the Society's illustrated lecture on the San Francisco–Oakland Bay Bridge. A general discussion followed.

University of Utah

Following a short business meeting, which took place on February 11, the University of Utah Student Chapter enjoyed the Society's slides on the Carquinez Straits Bridge. An informal talk on bridges now under construction was then given by Thomas C. Adams, associate professor of civil engineering at the university.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for May

Among the articles scheduled for the May issue is one by Gilbert F. White, chairman of the Water Resources Committee of the National Resources Committee, on the need for a refinement of the present technique for estimating the economic justification of flood-protection projects. The following matters of policy requiring definition are considered: Are potential as well as existing benefits evaluated? Are general as well as special benefits and costs evaluated? On what basis are total costs obtained and benefits computed? A method is then suggested for clearing up these questions and for remedying deficiencies in fact-finding technique. The article is timely in view of the large-scale flood-protection program launched under the Flood Control Act of 1936.

Fundamental aspects of soil stabilization, particularly as applied to subgrades, are reviewed in the second article, by W. S. Housel, Assoc. M. Am. Soc. C.E., associate professor of civil engineering at the University of Michigan. Properties of soil mixtures, rational methods of proportioning, and special stabilizing processes are taken up in turn. Professor Housel points out that although many important problems remain to be solved, extensive investigations now under way will make possible continued improvement in soil stabilization and an increasing field of practical application.

In another article scheduled for the May number of Civil Engineering, Paul A. Smith, Assoc. M. Am. Soc. C.E., lieutenant, U. S. Coast and Geodetic Survey, describes a number of recent developments which have contributed to the economy and accuracy of nautical chart making. These include the taut-wire apparatus, the sono-radio buoy, and the fathometer. The taut-wire apparatus, or "sea-going tape," permits relatively precise measurements to be made at sea in comparatively shoal water. By automatically relaying the sounds of a surveying vessel's bombs transmitted to them through the intervening water, sono-radio buoys provide an effective means for position-finding. Accurate soundings are taken in modern hydrographic work by the use of two different types of fathometer, designed for use in deep and shallow water, respectively.

If space permits, there will be included an informative historical article by W. H. Boyer and I. A. Jelly on an iron suspension bridge built across the Lehigh River near Palmerton, Pa., in 1826. This structure was in service for more than a century, but finally yielded place to a modern concrete span in 1833. It was probably the last surviving specimen of the type patented in 1803 by James Finlay, pioneer American builder of iron bridges. Mr. Jelly has illustrated the article with sketches of the bridge and of the furnace and forge at which the iron was produced and worked.

Engineering Students Find English Worth While at University of Virginia

When the English faculty of the University of Virginia found difficulty in interesting engineering students in Beowulf and Browning, they set about to discover what could be done about it. As a result, the department of engineering now conducts its own English courses, and on a somewhat unusual plan.

Even in the first term, the engineering approach is emphasized in composition. For example, as a subject for themes, "Sunset in the Mountains" has been replaced by "The Parking Problem at the Stadium." The treatment is not expected to be technical; the idea is simply to provide material that is closely tied in with the student's future career. Public speaking is also taught in the first year, so that students will be encouraged to take part at once in the work of their professional societies.

Literature is not neglected, but the method of presenting it is unique. Once a week a lecture is given on some of the great books of the world and their place in an engineer's cultural life, and after each lecture those students who are acquainted with the books under discussion are invited to give their personal opinions. From time to time professors of engineering are invited to address the class on "Books I Read for Pleasure." The object here is to show the students at an early stage in their careers that people who are not concerned with English classes find good reading a source of inspiration and pleasure.

During the third year, each student must prepare two papers of at least 2,000 words each, on a technical subject approved by one of the engineering faculty. Each paper is mimeographed and distributed to the class, and then read by the author. As he reads, the other students check all material and copy for errors of all kinds. When he finishes, he must answer questions from the floor. Then each member of the class writes a brief criticism of both the paper and the presentation, and all of these are returned to the author.

Other subjects taken up in the third year are business letters and report writing. Literature again is in the curriculum. In the fourth year there is no set course in English, but all reports prepared for other courses are checked by the English instructors.

In the fifth year, there is an old-fashioned Oxford reading course for students who elect to do some concentrated reading to fill up gaps in their background. Naturally each student has a different problem and must be assigned the reading that best fits his case.

In charge of the engineering courses is Prof. L. J. Vaughan, who has supplied the information for the present article.

Public Projects Efficiency Bill in N.Y. Legislature

A bill that would permit state agencies and local legislative bodies to employ independent engineers to check plans for public improvements has again been introduced in the New York Legislature by State Senator T. C. Desmond, M. Am. Soc. C.E.

The bill, known as the "Public Projects Efficiency Law," would permit independent engineers to be retained whenever a public project is contemplated or authorized by the state or any of its subdivisions. These engineers would be empowered to study and report on such matters as the feasibility of the project, the extent of the public benefit that would acrue from it, suitability of the selected site, desirable changes in plans and specifications, reasonable cost of the project as planned, and the probable cost of a recommended substitute. Although these recommendations would not be binding, they would be brought to public attention by publication in newspapers of general circulation.

Senator Desmond first presented his bill in 1936, but it failed of passage in that session of the legislature. The present bill has the support of a number of engineering organizations as well as individual engineers.

SPRING MEETING OF THE SOCIETY, April 21–24, 1937, in San Antonio, Tex.

Stopping an Underground Fire in Ohio

IN THE VICINITY of New Straitsville, Ohio, it is estimated that $50,000,000 worth of bituminous coal deposits have been destroyed by mine fires that have been burning continuously for 53 years. The condition is of especial interest at the present time because of the strenuous efforts now being made to stop the progress of the conflagration. The work is being conducted as a WPA project.

On three separate fronts, tunnels are being dug through bottlenecks of the coal bed (Fig. 1). When completed, they are to be filled with non-combustible material to form a barrier against the flames.

Whenever possible, the tunnels follow old mine workings that were abandoned 30 or 35 years ago. This is often difficult, however, for in the intervening years many unrecorded cave-ins have occurred, and many large pools have been formed by the infiltration of surface water. Sometimes it proves to be more economical to tunnel around such obstructions than to penetrate them. Hence the course of the tunnel can be planned definitely only a short distance in advance of its actual construction.

As the shale immediately above the coal bed in the New Straitsville section has a considerable content of oil and tar, it is highly combustible. Hence in order to make sure that the fire will not cross

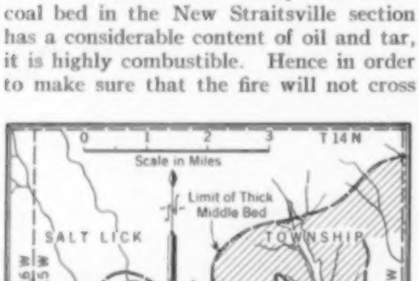


FIG. 1. A PART OF THE HOCKING VALLEY COAL FIELD, SOUTHEASTERN OHIO, SHOWING LOCATION OF FIRE-BARRIER PROJECTS

Coal Deposits Are Shown Shaded. The Fires at Present Are Limited to the Area Between the Barriers

over the barriers, the workers must remove the shale and slack above the coal as well as the coal itself.

Barrier C, the project west of New Straitsville, is the shortest. It is more immediately threatened by the mine fire than the other barriers. Between 500 and 700 ft from the barrier site, the billowing smoke of the mine fire is a constant reminder that flames are rapidly approaching the tunnel. Three shifts of workers labor day and night to push the tunnel through before the fire reaches the bottleneck. If they fail, coal fields valued in the millions will be threatened.

Barrier A, northeast of New Straitsville, is the largest individual project. This tunnel will be about a mile in length, with stripping on each end of the surface. Along the route an underground body of water was encountered that must be drained before the tunnel can be completed. Its depth and extent cannot be determined at present, for no elevations are indicated on the old mine plans, and it is impossible to make any explorations before at least a part of the water is removed. This will be done by constructing a drain through a drift entry to a nearby abandoned mine. The results of this operation will determine what must be done next. Preparations are being made to run the tunnel through from the drift entry, however, in case sufficient water is not taken off by the ditches.

Strangely enough, water, if it is left in the mine, will not check the fire. Since the shale above the coal bed is combustible the fire spreads through it and crosses over the water just as easily as though it were burning through solid coal. Likewise, the fire may burn beneath the water, since some 18 in. to 2 ft of coal was left at the bottom of the mine because of its high sulfur content. This coal burns readily when the mine fire reaches it, and forms an ash seal that enables the fire to cross beneath the water to the coal on the other side of the tunnel.

Oil fields in the fire area further complicate the problem. When the proposed line of a tunnel is intercepted by an oil-well shaft, the danger of poisonous gases is increased. Oil wells are actually in operation within a few feet of fissures through which come clouds of smoke from the raging fire beneath the surface. The barriers, in some instances, will run close to the wells, and in these danger areas careful explorations must precede every step of the work. A sudden inrush of gases might result disastrously for the workers.

Every known safety precaution is being used in the prosecution of this work. A safety engineer, who makes frequent inspections of the workings, is employed. The equipment includes modern gas-detecting apparatus; electric-battery cap lamps for illumination; permissible explosives for blasting; and safety hats, safety shoes, and goggles for all underground workers. Workers are trained in the use of mine rescue apparatus and in methods of first aid to the injured. Regular safety meetings are held, at which safety problems are discussed.

SURFACE EVIDENCE OF COAL MINE FIRE ADJACENT TO OIL WELL IN NEW STRAITSVILLE FIELD

The New Straitsville mine fires were started in 1884, during a bitter strike. The persons responsible for this act were never identified.

If the fires are not checked, they may continue to burn for another 150 or 200 years. Valuable deposits to the west, south, and northeast are threatened, and several hundred million dollars worth of coal will be saved if the work is completed before the fire eats through.

The project employs about 250 workers, under the supervision of James R. Cavanaugh, chief engineer; A. J. Laferty, general superintendent; Michael A. Boyle, project engineer; and R. R. Eaton, safety engineer. The U. S. Bureau of Mines designed the plans for the work, and is acting in an advisory capacity.

This item was prepared from material supplied by the information service of WPA, Washington, D.C., and W. J. Fene, of the Bureau of Mines Experiment Station, Pittsburgh, Pa.

Arbitration Journal Established

PUBLISHED by the American Arbitration Association in collaboration with the Inter-American Commercial Arbitration Commission and the Chamber of Commerce of the State of New York, *The Arbitration Journal*, to be issued quarterly, will show arbitration developments in various fields. Thus it will serve not only as a history, but also as a medium for the exchange of ideas.

The first issue, which appeared on January 25, 1937, indicates the wealth of material to be explored and recorded. A distinguished group of foreign collaborators furnishes news of arbitration from all parts of the world. In another section are recorded the achievements

of the Inter-American Commercial Arbitration Commission, which is providing a workable system for settling disputes arising out of trade between citizens of different American countries. A law-review committee reports and discusses judicial decisions that daily interpret the arbitration law, and the story of an outstanding arbitration award is included as an example of actual accomplishments.

One of the interesting features of each issue is to be a symposium on arbitration in a particular field. The January number includes a symposium on arbitration in insurance. The April symposium, "Arbitration in the Real Estate and Construction Fields," should be of particular interest to engineers.

Among the recent arbitration developments in the construction industry are the revision of the standard contract form of the American Institute of Architects to include an improved arbitration plan; the issuance of a short form for small construction contracts for use by the Federal Housing Commission, which includes a similar arbitration provision; the use of arbitration by one association in the building industry in its fair trade practice agreement; and the increasing use of arbitration in public works contracts.

Wise and Otherwise

The following unusual problem has been submitted by Prof. E. L. Ingram, M. Am. Soc. C.E.

At a right-angled intersection of two straight roads Professor Abercrombie encountered a man, his wife, and their child. The father and mother were engaged in an earnest discussion, and upon learning the mathematical nature of the question, the Professor at once took an active part.

It appeared that as the mother stood at the intersection a short time previous to the Professor's arrival, the child left her side and wandered at a uniform rate up the crossroad. At that particular moment it happened that the father, then a moderate distance away on the main road, was looking at his watch so that he knew the time. He gave chase immediately across fields at a uniform rate of 600 ft per minute. Moving always directly toward the fugitive, he reached the crossroad, picked up the child, and maintained his original speed back along the crossroad to the mother.

The total time consumed in running (neglecting the second or two lost at the point of capture) was found to be exactly 4 minutes. The mother expressed great admiration for this burst of speed but also wished to know how fast the child had been able to toddle. No way of obtaining this result was immediately apparent, since the point at which the child had been picked up could not be relocated. It was at this juncture that Professor Abercrombie joined the group.

When the question at issue had been explained to him, the Professor asked whether the starting point of the father's run could be identified. The reply being in the affirmative, he requested that the father time himself at the same speed down the main road (which neither child nor man had traversed as yet) from the start to the intersection. The test run was completed in 2 minutes, 40 seconds.

With this bit of information the Professor announced that he was fully prepared to compute the speed of the child. He characterized the path followed by the father from the start to the point of capture as the simplest case of the mathematician's pursuit curve, and stated that its exact length is equal to the quotient obtained by dividing the distance on the main road between the start and the intersection by the difference between unity and the square of the fraction formed by placing the speed of the child over that of the man.

The father argued at once that knowledge of this formula was useless, since the length of the curve was unobtainable. Professor Abercrombie, however, maintained that sufficient information was available to find the child's speed by some simple computations. Was he correct in this view, and if so, what was the child's speed?

In March's problem, Professor Abercrombie approached one of three aborigines and asked him what color feet he had. (By reputation, natives with red feet invariably tell the truth, while those with white feet invariably lie.) The reply being in a strange tongue, the Professor asked the second native what the first had said, and was told, "He says he has red feet." With his usual thoroughness the Professor next asked the third native what color feet the second one had. The reply was, "He has white feet." From these facts it was required to deduce the color of the third native's feet.

Under the circumstances, the first native must have said that he had red feet, since if in fact he did have red feet he would have told the truth and have answered "red," whereas if he had had white feet he would have lied and still have answered "red." The second native, who stated that the first had said "red," was therefore telling the truth and accordingly had red feet himself. Hence the third native, who said that the second had white feet, was lying and must have had white feet.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

M.I.T. Offers Scholarships in City Planning and Summer Course in Materials

Two Research Scholarships of $500 each, covering tuition in the graduate year, are open at the Massachusetts Institute of Technology for the school year 1937-1938, to candidates for the degree of master in city planning. In addition to meeting the requirements for entrance to the graduate school, an applicant must have at least one year's practical work in the field of city planning or housing. Successful candidates, in addition to completing the requirements for the graduate degree, will be required to give additional time to a research program under the direction of the research adviser.

Applications for these scholarships should be filed with Dean William Emerson, School of Architecture, Massachusetts Institute of Technology, 491 Boylston Street, Boston, Mass., not later that April 30, and should be accompanied by a transcript of the applicant's scholastic record; the names of at least two practicing architects or engineers who have personal knowledge of the applicant; and a typewritten, illustrated report describing the scope of the work done by the applicant since graduation.

The Institute also announces a special summer school and conferences on strength of materials, to run for four weeks beginning June 21, 1937. The subject of creep will be presented by Dr. A. Nadai, of the Westinghouse Electric and Manufacturing Company, and lectures on fatigue will be given by Dr. H. J. Gough of the National Physical Laboratory, England. The lectures on strength of materials will be given by members of the Institute staff. Laboratory exercises in the testing of metals will make use of the more modern measuring instruments and apparatus.

For the complete program the tuition fee will be $80. Owing to limitation of laboratory facilities, admission to the school will be in order of application. All those intending to take part should register by June 1. Further particulars may be obtained from Prof. John M. Lessells, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

A Cooperative Effort in Rural Highway Planning

Up-to-date, detailed road maps showing points of historical and natural interest are a welcome innovation to vacationists in certain counties in Missouri's "playground"—the sparsely settled mountainous region in the southern part of the state. These maps are the visible evidence of a comprehensive research project now under way in highway planning for rural counties, and much of the work on them has been done by undergraduate students at the Missouri School of Mines at Rolla.

The project was initiated in December 1933 by the Citizens' Road Association and the Missouri State Highway Department, and was made possible by a unique combination of interests. In order to obtain reliable data on county roads, the highway department paid mileage for the field workers. The counties, anxious to have complete maps showing tourist attractions as well as roads, furnished FERA supervisors from their allotments.

Engineering supervision was donated by the civil engineering staff at the School of Mines, and the students themselves performed the work for college credit. Resort owners, merchants, and others made possible the printing and free distribution of the maps by purchasing advertising space on the folders.

Students from Washington University and the University of Missouri also took part in the early part of the program, preparing general planning reports for road development in seven rural counties. In 1935 these reports were the only known ones dealing with such regions; until that time county highway planning work had been confined to wealthy, heavily populated districts. These reports were of a somewhat general nature. More recently, thorough planning reports have been prepared at the School of Mines for two counties, based on an examination of each tract of land in the area covered. Tentative plans have been made to publish one of these as a guide for future planning in thinly populated regions of limited resources.

This information has been supplied by Joe B. Butler, M. Am. Soc. C.E., who as professor of civil engineering at the School of Mines has been in charge of the project.

Brief Notes from Here and There

Two of a series of three volumes summarizing data on the construction industry have recently been released by the Bureau of the Census, Department of Commerce. In 1935, the first volume reveals, $1,622,862,000 worth of construction work was done in the United States by 75,047 contracting establishments. Of the total work, 55.1 per cent was private construction and 44.9 per cent public construction. As to types of work, 58.2 per cent of the total expenditure went to general contractors (24.6 per cent for buildings, 17.3 per cent for highways, and 16.3 per cent for heavy construction) and the remaining 41.8 per cent went to special trade contractors (carpentering, electrical work, heating and plumbing, roofing, and so forth). The figures do not include construction done by government agencies and others than contractors. They were collected early in 1936 by a canvass of contracting establishments in every county in the United States.

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REPRODUCTIONS of scientific literature on films smaller than a postage stamp can now be obtained from the Documentation Division of Science Service, Washington, D.C., at a cost of one cent a page. The films can be read with makeshift apparatus—microscopes, slide film projectors, or hand lenses—and an inexpensive "microfilm viewer" will soon be on the market. This service is at present available for material in the library of the U. S. Department of Agriculture, and eventually it is hoped to extend it to other libraries.

THE CONFERRING of honorary degrees upon outstanding members of the profession was a feature of the twenty-fifth anniversary celebration of the Johns Hopkins School of Engineering, held in February 1937. Among those thus honored were John E. Greiner, Hon. M. Am. Soc. C.E., and Abel Wolman, M. Am. Soc. C.E., both of whom were awarded the degree of doctor of engineering. The presentation took place on February 22.

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HONORARY degrees were conferred upon eight scientists of international reputation by George Washington University at the winter convocation held on February 22, 1937. Among those thus honored was William Bowie, M. Am. Soc. C.E., who was awarded the degree of doctor of science.

NEWS OF ENGINEERS

Personal Items About Society Members

ALFRED T. GLASSETT, formerly assistant secretary of the Barney-Ahlers Construction Corporation, of New York City, is now vice-president and secretary of the W. J. Barney Corporation, which is the new name of the organization.

ARTHUR R. SMITH has resigned as engineer of tests for the Indiana State Highway Commission to become development engineer with the Moulding-Brownell Corporation of Chicago, Ill.

VIRGIL I. DODSON is now in the U. S. Engineer Office at Milwaukee, Wis., where he is inspector on dredging and harbor construction.

D. B. PACKARD, JR., previously a junior draftsman in the North Carolina State Highway and Public Works Commission, is now assistant supervisor of building repairs for the Atlantic Coast Line Railroad Company at Rocky Mount, N.C.

JAMES B. PENDLETON is now structural engineer in the engineering division of the Phillips Petroleum Company at Bartlesville, Okla. Formerly he was structural designer for the Kansas State Highway Commission at Topeka

A. V. MCEOWEN, bridge designer with the Indiana State Highway Commission, has resigned to accept a similar position with the Vincennes Bridge Steel Corporation in Vincennes, Ind.

ARTHUR W. BUSHELL, engineer of contracts and construction for the Connecticut State Highway Department, was recently elected president of the Connecticut Society of Civil Engineers. Mr. Bushell's activities in this organization have included two years' service on the board of directors and service as second and first vice-presidents.

V. J. BEDELL was recently elected general manager and chief engineer of the New Orleans Public Belt Railroad, with headquarters in New Orleans. He was previously chief engineer.

ROBERT B. BROOKS, consulting engineer of St. Louis, Mo., has been appointed a member of the Missouri State Highway Commission by the governor of the state.

JOHN W. WHEELER recently resigned from the Indiana State Highway Commission to become engineer of highway negotiations for the Burlington Railroad.

A. W. ROHLWING, formerly structural field engineer in the Indianapolis office of the Portland Cement Association, has been appointed district engineer in charge of the work of this organization. His headquarters are still in Indianapolis.

LORING O. HANSON has resigned as instructor in the mechanics department of the University of Wisconsin to enter the employ of the Portland Cement Association in Chicago.

HAROLD A. SCHAILL has resigned as junior engineer with the U. S. Forest Service at Asheville, N.C., to become junior hydraulic engineer in the engineering data division of the Tennessee Valley Authority at Knoxville, Tenn.

GEORGE S. KNAPP, chief engineer of the Division of Water Resources of Kansas, was elected vice-president of the Kansas Engineering Society for 1937 at the annual meeting, held in Topeka in February.

CHARLES W. YODER has taken a position in the erection department of the Bethlehem Steel Corporation and is employed on the new plate mill at Sparrows Point, Md. Formerly he was assistant engineer in the operating department of the Pennsylvania Shipping Company.

JOHN L. SAVAGE, designing engineer in the Denver office of the U. S. Bureau of Reclamation, was recently awarded a gold medal by the Colorado Engineering Council for distinguished engineering service. Since 1924 Mr. Savage has been in charge of all designing work, and in this capacity directed the plans for such great projects as Boulder Dam and Grand Coulee Dam.

KENNETH F. PARK has been promoted from the position of assistant eastern sales manager and chief field engineer of R. G. Le Tourneau, Inc., of Peoria, Ill., and Stockton, Calif., to that of manager of a new department of promotional engineering being formed by this organization. The new department will accumulate and maintain for the benefit of contractors and others a constantly current fund of data on the best construction practices.

ARNOLD L. CONDRON has resigned as bridge designer for the Kansas State Highway Commission to join the engineering faculty of Kansas State College, where he is assistant professor in the department of applied mechanics.

Harold J. MacDonald, formerly field supervisor of construction for the Colonial Beacon Oil Company, is now engineer for F. Leroy Fox, Inc., of Boston, Mass.

DECEASED

Angus Francis Barclay (M. '28) formerly general manager of the New Orleans Public Belt Railroad, died in New Orleans, La., on January 31, 1937, at the age of 58. From 1906 until 1912 Mr. Barclay was connected with the New Orleans Public Belt Railroad—for the first two years as field engineer and later as chief engineer. For the next three years he was resident engineer for the Texas and Pacific Railroad on the construction of passenger and freight terminals. In 1915 he returned to the New Orleans Public Belt Railroad as chief engineer, and in 1934 he was made general manager. Mr. Barclay resigned from this position a month before his death.

George Archibald Graham (M. '26) civil engineer and surveyor of Jacksonville, Fla., died at Hines, Ill., on February 11, 1937. Mr. Graham, who was 61, was born at Fort Ricasoli, Malta. From 1896 to 1904 he was town engineer for Witney, England; from 1905 to 1911, assistant engineer on survey and construction for the National Transcontinental Railway of Canada; and from 1912 to 1918, engineer and draftsman for the city of Jacksonville, Fla. In 1921, after two years of service in the Engineer Corps of the Army at Camp Dix, N.J., he established a consulting practice at Daytona Beach, Fla. In 1931 he returned to Jacksonville.

Roy Husselman (M. '20) consulting engineer of Cleveland, Ohio, died in Memphis, Tenn., on August 6, 1936. Mr. Husselman was born at Auburn, Ind., on January 7, 1883, and educated at Purdue University and Carnegie Institute of Technology. From 1906 to 1912 he was office chief engineer on maintenance of way at Pittsburgh, Pa., for the Pennsylvania Railroad lines west of Pittsburgh, and from 1912 to 1916 was engineer of general construction in the division of light and heat of the city of Cleveland. In the latter year he became a member of the consulting firm of F. W. Ballard and Company, where he remained until 1920 when he established his own practice in Cleveland. Mr. Husselman was the author of various technical papers.

Roderic Pearson (Assoc. M. '22) highway bridge engineer with the U. S. Bureau of Public Roads, died in San Francisco, Calif., on February 4, 1937. Mr. Pearson was born in Portland, Ore., October 1, 1893, and graduated from Oregon Agricultural College in 1916, receiving the civil engineering degree. Except for a short period of enlistment during the war with the 17th Recruit Company at Fort McDowell, Mr. Pearson was with the U. S. Bureau of Public Roads from 1918 on—four years at Portland, Ore., three at Ogden, Utah, and the last twelve at San Francisco.

Alfred Douglas Flinn (M. '05) director of the Engineering Foundation, New York City, died in Scarsdale, N.Y., on March 14, 1937, at the age of 67. Dr. Flinn was born in New Berlin, Pa., and educated at the Worcester Polytechnic Institute and Massachusetts Institute of Technology. From 1895 to 1902 he was with the Massachusetts Metropolitan Water Works, and from 1902 to 1904 he was managing editor of the *Engineering Record*. From 1905 to 1918 he was with the Board of Water Supply of the City of New York, reaching the position of deputy chief engineer. His work for the latter

Alfred Douglas Flinn

organization included the designs for the reservoirs, dams, and aqueducts of the Esopus and Schoharie water systems. In 1918 he was appointed secretary of the Engineering Foundation, and in 1922 he became director. From 1918 until 1934 he was also secretary of the United Engineering Society, which was later succeeded by the United Engineering Trustees, Inc. He was co-author of a *Water Works Handbook* and for twelve years editor of *Research Narratives*, published by the Engineering Foundation. From 1917 to 1919 Dr. Flinn served as Director of the Society.

Donald Benjamin Rush (M. '30) president of the Rush-Roberts Engineering Company, of Chicago, Ill., died in that city on February 15, 1937. Mr. Rush, who was 50, was born at Dana, Ind., and graduated from Rose Polytechnic Institute in 1910. His early engineering career included experience as assistant bridge engineer for the Chicago and Alton Railroad and as bridge designer for the Chicago Electrification Commission. In 1918 he became connected with the Robert W. Hunt Company, of Chicago, as designer and superintendent of construction of mining properties. Later he was assistant to the chief engineer and manager of the cement and concrete department. Upon the formation last year of the Rush-Roberts Company he became president.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Vsevolod Evguenievitch Timonoff (M. '93) of Leningrad, U.S.S.R., died on July 19, 1936. He was born in Odessa, Russia, on August 21, 1862, and was educated at the École National des Ponts et Chaussées in Paris and the Institute of Ways of Communication in St. Petersburg. From 1885 on he was professor of hydraulics and sanitary engineering in the latter institution as well as in technical universities. Among the most notable works executed by Professor Timonoff were the opening of Ladoga Lake for coastal navigation, the improvement of the Dnieper River, the extension of Libau Harbor, the regulation of the Volga, and construction of the bridges of Tvéz and Novgorod. He was the author of a vast number of technical publications and did much to promote international interest in hydraulics. In 1911 Professor Timonoff visited the United States and the Panama Canal.

William Stanton Twining (M. '13) of Ambler, Pa., died at Fort Myers, Fla., on February 8, 1937, at the age of 71. Mr. Twining was born at Titusville, Pa., and graduated from Allegheny College in 1887. From 1893 to 1910 he was chief engineer of the Philadelphia Rapid Transit Company, and from 1910 to 1916 was engineering manager for Ford, Bacon, and Davis, of New York City. In the latter year he became director of the Philadelphia Department of City Transit, where he remained until his retirement in 1924. Mr. Twining was in charge of the design and construction of the Market Street subway and the elevated railway in Philadelphia and was a director of the Frankford Elevated Railway.

William John Ubbink (Assoc. M. '35) Ozaukee County (Wisconsin) Highway Commissioner, died in Port Washington, Wis., on February 8, 1937. Mr. Ubbink was born at Port Washington on August 10, 1890, and educated at Chicago Technical College. From 1910 to 1918 he was engaged in harbor, bridge, and highway construction. During the war he served in the Engineers' Corps of the Army, and in 1921 he became highway commissioner of Ozaukee County. As such he was in charge of the construction of a highway system costing $3,000,000 as well as numerous other local improvements.

Rául Felix Valega (Jun. '27) chief field engineer for the Frederick Snare Corporation of Callao, Peru, died there on July 21, 1936. Mr. Valega, who was 32, was born in Lima, Peru. Following his graduation from the Catholic University of America in 1927, he became field engineer for the Frederick Snare Corporation. In 1932 he was promoted to the position of assistant engineer, and in 1934 was made chief field engineer.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From February 10 to March 9, 1937, Inclusive

Additions to Membership

Ahrano, Frederick William (Jun. '36), Project Engr., WPA of Florida, Dist. 9, Route 3, Box 457, Pensacola, Fla.

Ammazzalorso, Joseph Tobia (Jun. '36), 30 Yale Ave., Ossining, N.Y.

Anderson, Carl Alfred (M. '37), Chf. Engr., Middle Rio Grande Conservancy Dist. (Res., Elks Club), Albuquerque, N.Mex.

Anderson, Clark Mackee (Assoc. M. '36), Instrumentman and Chf. of Party, Los Angeles Flood Control Dist., Los Angeles (Res., 2344 Norwalk Ave., Eagle Rock), Calif.

Barfoot, Joseph Earl (Jun. '36), 5230 Fifteenth N.E., Seattle, Wash.

Bisso, Louis Clarence (Jun. '36), 240 Audubon St., New Orleans, La.

Bradley, Walter Schiess (Assoc. M. '37), Junior Civ. Engr., City of Los Angeles, Bureau of Eng. (Res., 113 South Lucerne Boulevard), Los Angeles, Calif.

Carboine, Francis Anthony (Jun. '36), 32 A Gordon St., West Somerville, Mass.

Chipley, Chesley Allen (Assoc. M. '37), Res. Engr., State Highway Dept., Fort Worth, Tex.

Clanton, Jack Reed (Jun. '36), Care, 6th Engrs., Fort Lewis, Wash.

Cookman, Willard George Minter (Jun. '36), Box 445, Utica, Ill.

Crandall, Frederick Bruce (Jun. '36), Computer, State Highway Dept. (Res., 1715 North East 50th Ave.), Portland, Ore.

Culp, Frank Edward (Jun. '36), Insp., State Highway Dept., 521 Harvard, North, Seattle, Wash.

Cushing, Jerome James (Jun. '37), 900 Edgemere Court, Evanston, Ill.

Dando, George Albert (Jun. '36), With Mount Vernon Bridge Co. (Res., 217 East Chestnut St.), Mount Vernon, Ohio.

De Hart, Bruce Harding (Jun. '36), 1312 Custer St., Laramie, Wyo.

Delaney, William Joseph (Assoc. M. '37), Designer, Design Div., Eng. Dept., Port of New York Authority 111 Eighth Ave., New York, N.Y. (Res., 7 Parkview Drive, Millburn, N.J.)

Dewey, Haywood Guion, Jr. (Jun. '36), Junior Engr., Bureau of Reclamation (Res., 555 South Corona St.), Denver, Colo.

DeWitt, Lyle Vinson (Jun. '36), 810 West Green St., Urbana, Ill.

Dibrell, William Warren (Assoc. M. '36), Chf. Building Insp., PWA, Housing Div., 2574 East 46th St., Cleveland, Ohio.

Drew, Freeman Pierce (Jun. '36), Draftsman, Pittsburgh-Des Moines Steel Co. (Res., 4615 Kingman Boulevard), Des Moines, Iowa.

Dugan, James Henry (M. '37), Engr. of Design, New York City Tunnel Authority, 200 Madison Ave., 9th Floor, New York, N.Y.

Elliott, Archer Thomas (Jun. '36), 3291 North 35th St., Milwaukee, Wis.

Erickson, Erick Boine (Jun. '36), Junior San. Engr., Constr. Div., RA (Res., 1711 East Capitol St.), Washington, D.C.

Fleming, James Aloysius, Jr. (Jun. '37), Junior Field Engr., WPA (Res., 23 Merritt Ave.), White Plains, N.Y.

Frank, Herbert Louis (Jun. '36), Care, West Slope Const. Co., Azusa, Calif.

Gagon, George F. (Jun. '36), With Boeing Aircraft Co., Eng. Dept. (Res., 2529 Fourteenth Ave., South, Apartment 611), Seattle, Wash.

Geltner, Carl (Jun. '37), Central Y.M.C.A., Baltimore, Md.

Greicus, Sigmund Edward (Assoc. M. '37), Asst. Civ. Engr., U. S. Forestry Service, Dept. of Agriculture (Res., 520 East Pine), Missoula, Mont.

Griffiths, Thomas William (Jun. '37), Surveyman, U. S. Engrs., 320 South Alexandria St., Los Angeles, Calif.

Hance, Tolliff Rhinesberg (Jun. '36), Box 402, Laramie, Wyo.

Harding, Robert Nelson (Jun. '36), 450 West Suffolk St., Dallas, Tex.

Hopkins, Martin Francis (Assoc. M. '37), Senior Structural Engr., Public Service Comm. of West Virginia (Res., 1715 Quarrier St.), Charleston, W.Va.

Hower, Nathan Ralph (Jun. '36), 8600 Fourth Ave., North, Birmingham, Ala.

Huskison, Christian Carll (Assoc. M. '37), Office Engr., State Highway Dept. (Res., 1433 East Brill St.), Phoenix, Ariz.

Hyde, Edward Ruddock (M. '36), Dean, Coll. of Eng., Univ. of the Philippines, Manila, Philippine Islands.

Jehle, Charles Andrew Peter (M. '37), With City of Long Beach, Long Beach (Res. 57 Nichols Ave., Brooklyn), N.Y.

Ketcham, Earl Francis (Assoc. M. '37), Superv. Engr. Insp., PWA (Res., 802 West A St.), North Platte, Nebr.

Kirkman, Reymond Fauche (Jun. '36), 150 Littleton St., West Lafayette, Ind.

Kulas, Frank Edward (Jun. '37), Engr. of Concrete Tests, Jones & Laughlin Steel Corporation, Pittsburgh (Res., 1414 Grandin Ave., Dormont), Pa.

Kuykendall, Aubrey Leon (Jun. '37), Engr.-Insp., Powell & Powell, Box 228, Terrell, Tex.

Lanham, Stanley Matthew (Assoc. M. '37), Public Utilities Engr., City Attorney, City of Los Angeles (Res., 3056 West 12th Pl.), Los Angeles, Calif.

Mabie, Henry Clay (Jun. '36), 70 Southbourne Rd., Jamaica Plain, Mass.

MacLean Mansell Lehigh (Assoc. M. '37), Asst. Engr., Rosoff Subway Constr. Co., Inc., 295 Madison Ave., New York (Res., 176 Hickory Grove Drive, Larchmont), N.Y.

McDonald, Robert Lee (Jun. '36), 5704 Sixteenth, N.E., Seattle, Wash.

Maher, Francis Joseph (Jun. '36), 1717 West 12th St., Brooklyn, N.Y.

Maier, Joseph (Assoc. M. '37), Vice-Pres., Balaban-Gordon Co., Inc., New York (Res., 21-09 A Forty-Sixth St., Astoria), N.Y.

Matheny, Charles Woodburn, Jr. (Jun. '37), Rodman, RA, Scottsboro, Ala. (Res., 809 South Orange Ave., Sarasota, Fla.)

Medbery, Hiram Christopher (Jun. '36), Draftsman, Alameda County Mosquito Abatement Dist., 2022 California St., San Francisco, Calif.

Mellinger, Frank Millin (Jun. '37), With Army Engrs., War Dept. (Res., 318 Adams St.), Zanesville, Ohio.

Millen, James Adsit (Jun. '37), Chf. of Party, Southern California Gas Co., Los Angeles, Calif.

Miner, Clarence Crosiar (Assoc. M. '36), Chf. Computer, TVA (Res., 405 South Germantown Rd.), Chattanooga, Tenn.

Momchiloff, Momchil Stephen (Jun. '36), 123 Lancaster St., Albany, N.Y.

Morgan, Newlin Dolbey, Jr. (Jun. '36), Y.M.C.A., Gary, Ind.

Morriss, Grover Cleveland (Assoc. M. '37), Chf. Cadastral Engr., Brazos River Conservation and Reclamation Dist. (Res., Kyle Hotel), Temple, Tex.

Muceus, Francis Kristian (Assoc. M. '36), Camp Supt., ECW, U. S. Forest Service, SCS (Res., 428 East Washington Ave.), Centerville, Iowa.

Olander, Harvey Chester (Jun. '36), Associate Engr., U. S. Bureau of Reclamation (Res. 614 Jackson St.), Denver, Colo.

O'Neill, Ralph Sheldon (Jun. '36), Hermosa, S.Dak.

Ortino, John Thomas (Jun. '37), Junior Hydr. Engr., Water Resources Branch, U. S. Geological Survey, 46 West 73d St., New York, N.Y.

Page, John Ruffner (Jun. '37), Chf. Civ. Eng. Aide, CCC, 3321 Company, Fort Monroe, Va.

Parlett, John Garland (Jun. '36), 131 Eleventh Ave., San Mateo, Calif.

Patterson, Hubert Fulton (Jun. '36), 1006 Jefferson Ave., Oxford, Miss.

Paul, Robert William (Jun. '37), With U. S. Engrs., War Dept., Mohawk Dam, Nellie (Res., 2005 North Maple Ave., Zanesville), Ohio.

Quackenbush, Cornelius Bogert (Jun. '36), 270 Union St., Hackensack, N.J.

TOTAL MEMBERSHIP AS OF MARCH 9, 1937	
Members	5,657
Associate Members	6,061
Corporate Members	11,718
Honorary Members	24
Juniors	3,436
Affiliates	87
Fellows	1
Total	15,266

Quine, Thomas Arthur (Jun. '37), Draftsman, State Highway Dept., 767 Twelfth St., Boulder, Colo.

Redmond, Wilbert (Jun. '36), With Gibbs & Hill, Pennsylvania Station, New York (Res., 143 Gansevoort Boulevard, Port Richmond), N.Y.

Ringelstein, Albert Charles (Jun. '36), 2883 Roosevelt Ave., New York, N.Y.

Roberts, Verlin Alfred (Affiliate '37), Supt. of Constr., Morrison-Knudsen Co., Inc., Holdredge, Nebr.

Saunders, Edward Watts (M. '37), Prof., Applied Math. and Civ. Eng., Univ. of Virginia (Res., 1006 East High St.), Charlottesville, Va.

Scantlebury, Woodman Francis (Jun. '37), Senior Engr., Chf. of Party, Eng. Dept., Nassau County; Asst. Engr., A. K. Piloff, Westbury (Res., 22 Second Ave., Port Washington), N.Y.

Schwartz, Jack William (Jun. '36), Box 1012, Eureka, Calif.

Scoular, Spencer Gray (Assoc. M. '36), Prin. Asst. to City Engr. and Deputy Drainage Engr., City Engrs. Dept. and Engrs. Dept., Drainage and Sewerage Board (Res., 11 Prestwick St.), Dunedin N.W. 1, New Zealand.

Shamburger, Roy Thomas (Jun. '36), 1313 Elmwood Ave., Fort Worth, Tex.

Shukle, Richard John (Jun. '37), 1411 Bissell Ave., Richmond, Calif.

Smith, Jack Ferguson (Jun. '36), 1003 Park View Ave., Dallas, Tex.

Soman, Robert (Jun. '37), 9318 Baldwin Ave., Forest Hills, N.Y.

Sterba, Antonin Messenger (Jun. '36), 405 East Main St., Ottawa, Ill.

Sturdy, Howard Henry (Jun. '36), Engr. and Estimator, Dravo Corporation, Neville Island Branch, Pittsburgh (Res., 520 Academy Ave., Sewickley), Pa.

Sturges, Thomas Benedict (M. '37), Chf. Engr. and Pres., Pennsylvania Drilling Co. (Res., 3136 Pioneer Ave.), Pittsburgh, Pa.

Suter, Walter Egloff (Assoc. M. '37), Res. Engr., State Highway Dept. (Res. 2305 Forrest St.), Beaumont, Tex.

Sverdrup, Leif John (M. '37), Cons. Engr. (Sverdrup & Parcel), 1848 Railway Exchange Bldg., St. Louis, Mo.

Tamargo, Manuel Rafael (Jun. '37), Linea 73A, Vedado, Havana, Cuba.

Torreyson, Charles Hall (Assoc. M. '37), Asst. Engr., U. S. Bureau of Agri. Eng., New Madrid, Mo.

Travaini, Dario (Assoc. M. '37), Supt., Activated Sludge Plant, City of Phoenix (Res., 1022 East Willetta St.), Phoenix, Ariz.

Trook, Mark Monroe (Jun. '36), 1326 Main St., Anderson, Ind.

Turnbull, Willard Jay (Assoc. M. '37), Chf. Soils Engr., The Central Nebraska Public Power and Irrig. Dist., Tri-County Project, Hastings (Res., 428 North 31st St., Lincoln), Nebr.

Turner, Cullen Yates (Jun. '36), Box 228 Sylvania Station, Fort Worth, Tex.

Verpillot, Emil Alexander (Assoc. M. '37), Asst. Engr., Dept. of Plant and Structures, Div. of Ferries, New York (Res., 192 Kingsley Ave., Westerleigh), N.Y.

Waller, Arthur Canning (Assoc. M. '36), With Shell Oil Co., Ashpalt Div., 100 Bush St., San Francisco (Res., 1933 Eldorado Ave., Berkeley), Calif.

Wells, George Ray, Jr. (Jun. '37), With Peoples Natural Gas Co., 545 William Penn Way (Res., 3258 Wainbell Ave., Dormont), Pittsburgh, Pa.

Weyher, Theodore Addison (Assoc. M. '37), 19 Spruce St., Watertown, Mass.

White, David Lindsay (M. '37), Chf., 1st Area, 2d New Orleans River Dist., U. S. Engr. Dept. (Res., 512 Walnut St.), New Orleans, La.

Whitney, Schuyler Allen (Jun. '36), Westover Rd., Troy, N.Y.

Wilson, John Hanly (Assoc. M. '36), Care, Lowe Machinery Co., 612 North Michigan Ave., Chicago, Ill.

Yates, Oscar Townsend (Assoc. M. '37), Associate Engr., Div. Engr's. Office, Ohio River Div., Corps of Engrs., Box 859, Cincinnati, Ohio.

Zwissler, Gordon Arthur (Jun. '37), 740 Franklin St., Wilkinsburg, Pa.

Membership Transfers

Andujar, Anthony Leveridge (Jun. '27; Assoc. M. '37), Asst. Res. Engr. Insp., PWA, 2 Lafayette St. (Res., 560 West 173d St.), New York, N.Y.

Angell, Lester William (Jun. '33; Assoc. M. '37), Asst. Structural Engr., TVA (Res., 300 Raleigh Ave.), Knoxville, Tenn.

Baker, Russell Curtis (Jun. '31; Assoc. M. '37), Engr., U. S. Engrs., U. S. Engr. Office, Box 8, Sardis, Miss.

Doten, Henry Leroy (Assoc. M. '30; M. '37), Constr. Engr., Bridge Div., State Highway Comm. (Res., 155 Sewall St.), Augusta, Me.

Drury, William George (Jun. '28; Assoc. M. '37), Asst. Valuation Engr., New York Water Service Corporation, 90 Broad St., New York, N.Y. (Res., 49 Olyphant Drive, Morristown, N.J.)

Farrisee, William James (Assoc. M. '28; M. '37), Associate Prof., Civ. Eng., Clarkson Coll. of Technology (Res., 22 Elm St.), Potsdam, N.Y.

Ferneau, Thomas Edgar (Jun. '27; Assoc. M. '28; M. '37), Res. Engr., State Div. of Highways, Dist. IV, 624 Fifth Ave., San Rafael, Calif.

Glückert, William John, Jr. (Jun. '26; Assoc. M. '37), Chf. Draftsman, Standard Oil Co. of Venezuela, Caripito, Venezuela.

Harder, Bernard Samuel (Jun. '35; Assoc. M. '37), Asst. Res. Engr., State Bridge Dept. (Res., 3518 Glenhurst Ave.), Los Angeles, Calif.

Holmes, Joseph Mark (Jun. '34; Assoc. M. '37), Asst. Engr., U. S. Geological Survey, Sacramento, Calif.

Hussey, Edgar William (Jun. '27; Assoc. M. '37), Sales Engr., Soulé Steel Co. (Res., 1526 North East 24th Ave.), Portland, Ore.

Jonsson, Alex Carl (Jun. '34; Assoc. M. '37), Asst. Supt., Siphons, Met. Water Dist. of Southern California, 2259 Wellesley Ave., West Los Angeles, Calif.

Latimer, Marion Millard (Jun. '29; Assoc. M. '37), Senior Supt., Starved Rock State Park, National Park Service, Dept. of the Interior, Camp SP-23, Utica, Ill.

Letourneau, Doria George (Jun. '27; Assoc. M. '37), Res. Engr., Robinson & Steinman, 117 Liberty St., New York, N.Y. (Res., Sargent House, Sargentville, Me.)

Long, George Vilas (Assoc. M. '27; M. '36), Asst. Field Engr., in Chg., Coshocton County, WPA of Ohio, Dist. 4 (Res., 521 South 14th St.), Coshocton, Ohio.

Moore, Walter Parker (Jun. '27; Assoc. M. '36), Cons. Engr., 803 Sterling Bldg., Houston, Tex.

Mower, Charles Mason, Jr. (Jun. '24; Assoc. M. '28; M. '37), Asst. Engr, The Pitometer Co., 50 Church St., New York, N.Y.

Nelson, Jabez Curry (Jun. '07; Assoc. M. '15; M. '37), Pres. and Gen. Mgr., Easy Washing Machine Corporation, Solar and Spencer Sts., Syracuse, N.Y.

O'Brien, Francis Joseph (Jun. '34; Assoc. M. '37), Supervisor of Inspection TVA (Res., 1043 Chickamauga Ave.), Knoxville, Tenn.

Orem, Hollis Milon (Jun. '29; Assoc. M. '37), Asst. Hydr. Engr., Water Resources Branch, U. S. Geological Survey, 208 Federal Office Bldg., San Francisco, Calif.

Paul, Ellis Ellsworth (Assoc. M. '27; M. '37), Asst. Engr., Ash-Howard-Needles & Tammen, 111 Eighth Ave., New York, N.Y.

Pearson, Arthur Seymour (Jun. '30; Assoc. M. '36), Insp., Civ. Eng. Dept., New York Edison Co., 4 Irving Pl., New York (Res., 710 Warburton Ave., Yonkers), N.Y.

Petrofesi, Michael Francis (Jun. '28; Assoc. M. '37), Senior Structural Draftsman, New York World's Fair, 1939, Inc. (Res., 100 Oliver St.), New York, N.Y.

Sporseen, Stanley Emanuel (Jun. '33; Assoc. M. '37), Junior Engr., U. S. Engrs., 2d Portland Dist., Bonneville, Ore.

Stevens, George (Jun. '27; Assoc. M. '36), Bridge Designer, State Dept. of Highways (Res., 303 East 10th Ave.), Olympia, Wash.

Theobald, John Jacob (Jun. '29; Assoc. M. '36), Cons. Engr.; Asst. Prof., Civ. Eng., Coll. of the City of New York, New York, N.Y.

Whyte, Clifford Riddle (Assoc. M. '27; M. '37), Engr. of Bridges, District of Columbia (Res., 1649 Hobart St., N.W.), Washington, D.C.

Williams, Byrd Moore, Jr. (Assoc. M. '35; M. '37), Res. Engr., City of Fort Worth (Res., 3137 Wabash Ave.), Fort Worth, Tex.

Williams, Gordon Ryerson (Jun. '29; Assoc. M. '36), Asst. Hydr. Engr., Water Resources Branch, U. S. Geological Survey, Washington, D.C.

Reinstatements

Clulo, James Aloisius, Assoc. M., reinstated Dec. 14, 1936.

Ellsberg, Harry, M., reinstated Feb. 3, 1937.

Knapp, Frank Hiram, M., reinstated Feb. 15, 1937.

Matteson, Frank Augustus, Jr., Jun., reinstated Feb. 10, 1937.

Mau, Carl Frederick, Assoc. M., reinstated Feb. 3, 1937.

Mikuriya, Tadafumi, Assoc. M., reinstated Feb. 10, 1937.

Scott, Robert Graham, Assoc. M., reinstated Feb. 11, 1937.

Seal, Benjamin Callison, Jun., reinstated Nov. 5, 1936.

Van Antwerp, Eugene Ignatius, Assoc. M., reinstated Feb. 9, 1937.

Uhr, Saul, Assoc. M., reinstated Feb. 9, 1937.

Wagner, Elmer Chester Louis, M., reinstated Dec. 9, 1936.

Yeager, Oswald Karl, M., reinstated Feb. 3, 1937.

Zahren, Roy, M., reinstated Jan. 29, 1937.

Resignations

Barlow, James Evans, M., resigned Mar. 1, 1937.

Frisch, Solomon, Jun., resigned Mar. 1, 1937.

GARDINER, ARTHUR PERRY, Jun., resigned Mar. 2, 1937.

HAGMANN, WAYNE W., Jun., resigned Feb. 25, 1937.

HATCH, LORANUS PENDLETON, Jun., resigned Feb. 11, 1937.

LEE, FRANK, M., resigned Feb. 16, 1937.

MASON, DRAPER COOLIDGE, Jun., resigned Feb. 24, 1937.

PALLER, BEN, Jun., resigned Feb. 25, 1937.

PETERSON, WILLIAM WINSOR, Jun., resigned Feb. 25, 1937.

RANDELL, RALPH REGINALD, M., resigned Feb. 10, 1937.

SCHOFIELD, EDWIN ROSE, M., resigned Mar. 2, 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

April 1, 1937 NUMBER 4

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years †	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.
† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

ACKERMAN, MANUEL, Pretoria, South Africa. (Age 37.) Asst. Engr., Irrigation Dept., Union of South Africa. Refers to L. A. Mackenzie, D. F. Marais, N. Shand, W. G. Sutton, C. V. von Abo.

ANDERSON, JOHN, Charleston, S.C. (Age 48.) Prof. of Civ. Eng., The Citadel (Military Coll. of South Carolina). Refers to W. J. Buchanan, J. E. Gibson, J. R. Haswell, E. G. Kastenhuber, Jr., A. F. Shure, C. R. Simpson.

ANDERSON, KENNETH BOYER, Columbus, Ohio. (Age 29.) Asst. Office Engr., WPA. Refers to C. Ash, D. W. Bingham, G. H. Elbin, R. L. Moore, H. A. Olson, J. R. Pollock, A. M. Steffes, A. R. Webb.

ARNOLD, HUGH MONTGOMERY, Conchas Dam, N.Mex. (Age 27.) Student Engr., War Dept., U. S. Engrs. Refers to J. B. Alexander, H. Kramer, J. R. Noyes, H. V. Pittman, C. W. Wright.

BAILEY, ELLSWORTH BARR, Concord, Calif. (Age 37.) Designer-Draftsman, Eng. Dept., Shell Oil Co. Refinery, Martinez, Calif. Refers to W. G. Frost, W. W. Hoy, I. O. Jahlstrom, J. S. James, F. W. Panhorst, R. J. Reed, D. R. Warren.

BEEBE, JOHN RICHARD, Youngstown, Ohio. (Age 24.) Draftsman, Truscon Steel Co. Refers to C. T. Morris, J. C. Prior.

BERTINO, FRED, New York City. (Age 29.) Engr. on construction, War Dept., Governors Island, New York City. Refers to L. V. Carpenter, A. Freihofner, R. E. Goodwin, N. J. Hainovsky, J. S. Peck, J. C. Rathbun.

BEST, WALTER EUGENE, Vicksburg, Miss. (Age 29.) Asst. Engr., U. S. Engr. Office. Refers to J. B. Alexander, H. C. Doverspike, A. F. Griffin, N. R. Moore, P. A. Perrin, G. M. Tapley.

BOYER, PETER BOYAJIAN, Portland, Ore. (Age 30.) Civ. Eng. Instructor, Head of Civ. Eng. Dept., Oregon Inst. of Technology. Refers to W. J. Krefeld, P. F. Stephens.

CAHILL, JOHN EDWARD, San Francisco, Calif. (Age 22.) Structural Engr., F. W. Kellberg. Refers to J. R. Cahill, R. P. Day, C. Derleth, Jr., E. L. Grant, W. L. Huber, J. B. Wells, C. T. Wiskocil.

CALLAND, ROBERT STEWART, Sacramento, Calif. (Age 47.) With U. S. Bureau of Reclamation, Central Valley Project, California. Refers to F. T. Crowe, S. O. Harper, L. M. Holt, J. L. Savage, R. C. Thaxton, W. R. Young.

CARDILE, FRANK, New York City. (Age 21.) Chf. of Party, WPA, Dept. of Hospitals. Refers to W. Allan, R. E. Goodwin, J. S. Peck, T. H. Prentice, J. C. Rathbun.

CHRISTENSEN, CHARLES CHAPIN, Washington, D.C. (Age 47.) Associate Structural Engr., Treasury Dept., Procurement Div., Public Bldgs. Branch. Refers to E. M. Frost, H. R. Kingsley, S. Lilienthal, L. G. Parker, H. Penn, M. Rosner, S. T. Smetters, F. D. Wilson.

COLE, KENERLY OREAR, Smyrna, Ga. (Age 33.) Promotion Engr., Portland Cement Association, Chicago, Ill. Refers to J. H. Archer, R. P. Black, A. J. Cooper, T. J. Durrett, Jr., R. G. Hicklin.

DARBY, WILLIAM DANIEL, West Allis, Wis. (Age 44.) City Engr., also private practice. Refers to B. E. Brevik, W. F. Cavanaugh, J. L. Ferebee, R. W. Gamble, R. C. Johnson, W. R. Reuter.

DAVIS, FRANK TERENCE, New York City. (Age 37.) Refers to F. M. Aguirre, H. H. Haggard, J. A. Sargent, H. Smith, M. T. Walsh.

DEFANT, RAYMOND TULLY, Popple, Minn. (Age 29.) Jun. Civ. Engr., U. S. Forest Service. Refers to C. L. Allen, C. M. Cade.

DURHAM, MAX JUDGE, Long Beach, Calif. (Age 31.) Field Engr., Hanrahan Co., Contr. Refers to G. E. Baker, R. B. Diemer, F. W. Hough, H. G. Matthews.

FARKAS, NICHOLAS, New York City. (Age 36.) Res. Engr. Inspector, PWA. Refers to C. E. Conover, R. H. Keays, J. H. Quimby, A. I. Raisman, P. L. Voss, J. P. J. Williams.

FLUHR, THOMAS WARREN, New York City. (Age 38.) Asst. Geologist, Board of Water Supply, Asst. to Cons. Geologist, Port of New York Authority, etc. Refers to O. H. Ammann, R. W. Armstrong, C. P. Berkey, H. R. Bouton, E. W. Bowden, C. S. Gleim, J. Mechanic, T. Merriman, R. Ridgway, J. C. Riedel, J. F. Sanborn, O. Singstad, W. E. Spear.

FULTON, EDWARD ARTHUR, St. Louis, Mo. (Age 38.) Cons. Engr. Refers to F. Bachmann, T. R. Camp, A. W. Consoer, K. Lindsey, G. R. Solomon.

GANNON, DONALD ARTHUR, Torrance, Calif. (Age 28.) Asst. Engr., U. S. Soil Conservation Service, Whittier, Calif. Refers to Q. C. Ayres, R. A. Floyd, A. H. Fuller, J. R. Maher, Sr., L. O. Stewart.

GHENT, PIERRE MOWELL, Washington, D.C. (Age 33.) Associate Town Planner, SRA

Refers to J. Barnett, A. G. Hayden, R. Mather, F. T. Norcross, G. W. Stephens, Jr.

GIALDINI, GENE JOHN, Philadelphia, Pa. (Age 32.) Eng. Aide, Philadelphia (Pa.) Navy Yard (testing laboratory); also Testing Laboratory Instructor, Drexel Inst. Evening School. Refers to R. A. Anderegg, H. C. Child, D. A. Keefe, W. Z. Kline, H. B. Luther, R. W. Renn.

GIESEN, FRANCIS EDWARD, Buchanan Dam, Tex. (Age 40.) Chf. of Party, Lower Colorado River Authority. Refers to H. Cook, E. O. Heaton, H. R. F. Helland, C. G. Levander, R. J. McMahon, E. J. von Rosenberg, H. U. von Rosenberg.

GREEN, WHARTON, New York City. (Age 57.) Liaison Engr., New York World's Fair 1939, Inc. Refers to O. H. Ammann, F. S. Crowell, W. H. Latham, E. R. Needles, C. S. Proctor, O. Singstad, C. E. Trout.

GRIGGS, CHANDLER BABBITT, Concord, N.H. (Age 27.) Draftsman, New Hampshire Water Resources Board. Refers to F. E. Everett, F. W. Garran, R. S. Holmgren, R. R. Marsden, A. P. Miller.

HALE, JOHN SYMONS, Montgomery, Ala. (Age 30.) Jun. Hydr. Engr., Dept. of Interior, U. S. Geological Survey, Water Resources Branch. Refers to D. H. Barber, H. Beebe, J. C. Pinney, L. B. Ryon, Jr., L. V. Uhrig.

HAY, JOHN LEONARD, Santa Fe, N.Mex. (Age 31.) Engr., in charge of Eng. Dept. in absence of Supt., New Mexico Power Co. Refers to E. L. Barrows, J. H. Bliss, P. S. Fox, B. Johnson, G. D. Macy, G. M. Neel.

HOOKHAM, ROBERT ERNEST, Topeka, Kans. (Age 34.) Designer, Kansas Highway Comm. Refers to A. L. Condron, F. W. Epps, T. Germundsson, L. Grover, W. S. Thomson, C. C. Wright.

HUANG, WEN HSI, Denver, Colo. (Age 28.) Jun. Engr., U. S. Bureau of Reclamation. Refers to L. M. Gram, H. W. King, L. C. Maugh, R. H. Sherlock, C. O. Wisler.

JONES, FRANCIS ROSSER, Mt. Lebanon, Pittsburgh, Pa. (Age 36.) Associate Engr. (Sub-Project Engr.), U. S. Engr. Office, Pittsburgh, Pa. Refers to A. L. Alin, C. B. Cornell, G. G. Dixon, H. C. Doverspike, D. P. Grosshans, C. L. Hall, N. H. Jebejian, T. T. Knappen, C. E. Sherman, E. L. Winslow, Jr.

KASTNER, ALFRED, Washington, D.C. (Age 36.) Prin. Archt., Constr. Div., Resettlement Administration, U. S. Dept. of Agriculture. Refers to C. D. Babcock, J. B. Corridon, J. A. Fouilhoux, I. Harby, W. J. Luff, C. F. Puff, Jr., C. F. Ruff.

KELLOGG, MARKOE ORCUTT, Boston, Mass. (Age 26.) Draftsman, Sun Oil Co., Sales Constr. Dept. Refers to F. A. Barnes, H. Manley, Jr., J. E. Perry.

KESSLER, LEWIS HANFORD, Madison, Wis. (Age 37.) Acting Chairman (Asst. Prof.), Hydr. and San. Eng., Adv. Hydr. Water Supply, Thesis Seminar, Univ. of Wisconsin. Refers to J. G. Bennett, J. S. Bowman, F. M. Dawson, D. W. Mead, W. A. Peirce, F. E. Turneaure.

LANE, EDWARD NEIL WILTAMUTH, Lincoln, Nebr. (Age 28.) Bridge Inspector and Instrumentman, Nebraska Dept. of Roads and Irrigation. Refers to H. L. Handley, J. G. Mason, D. W. Mead, A. L. Ogle, H. G. Schlitt, F. E. Turneaure.

LOVAN, CHARLES FELIX, Jacksonville, Fla.* (Age 35.) Hillyer & Lovan, Engrs. and Contrs. Refers to R. L. Cashen, S. R. Evans, W. R. McCann, H. P. Mobberly, T. C. Morris, J. F. Reynolds, W. E. Reynolds, W. Rowland, W. G. B. Thompson.

MCDOWELL, LESLIE PAUL, Topeka, Kans. (Age 33.) Office Engr., PWA. Refers to H. D. Barnes, B. Boyle, R. B. Lawrence, R. J. Paulette, R. E. Reed.

MCKINSTRY, ROBERT STANLEY, Seattle, Wash. (Age 22.) Engr., Boeing Airplane Co. Refers to J. C. Greely, G. E. Hawthorn, C. C. More, F. H. Rhodes, Jr., W. D. Shannon, R. G. Tyler, R. B. Van Horn.

MCNALLY, CHRISTOPHER JOSEPH, Allentown, Pa. (Age 35.) Chf. Engr., Cement Gun. Co. Refers to B. F. Biemann, B. C. Collier, C. S. Gleim, M. I. Killmer, H. L. King, J. Mechanic, P. M. Sax.

MITCHELL, ANSEL NICHOLS, Kansas City, Mo. (Age 33.) Supt. of Constr., J. C. Nichols Investment Co., in charge of construction, Country Club Dist., Johnson County, Kans. Refers to E. K. Carter, J. W. Ivy, J. C. Long, M. S. Murray, L. B. Roberts, T. D. Samuel, Jr., W. M. Spann, N. T. Veatch, Jr., R. W. Waddell, R. P. Woods.

NEUMANN, BOHUSLAV, New York City. (Age 48.) Refers to N. A. Alexieff, W. D. Binger, W. Ginsberg, C. P. Melioransky, M. M. Zolotareff.

OLMSTEAD, ERI, Detroit, Mich. (Age 51.) With FEA of PW as Traveling Engr. Inspector for State of Michigan. Refers to W. C. Hirn, R. L. McNamee, R. Norris, M. F. Ohr, D. R. Wells.

OSTRANDER, HOWARD WILLIAM, Jackson, Calif. (Age 30.) 1st Lieut., 392nd Inf. on active duty with CCC. Refers to C. Crandall, J. E. Perry, P. H. Underwood.

PASAREW, ISADORE ALVIN, Baltimore, Md. (Age 27.) Asst. Engr., Inspection Div., PWA. Refers to P. E. Borchers, F. O. Dufour, A. C. Klingenberg, J. W. Richardson, F. H. Shaw, A. E. Steere, A. Wolman.

PATCH, MARSHALL ARTHUR, Tucson, Ariz. (Age 23.) Jun. Hydr. Engr., U. S. Geological Survey. Refers to W. E. Dickinson, G. F. Eckhard.

PATTERSON, WILLIAM LAWRENCE, Kansas City, Mo. (Age 32.) Designer with Black & Veatch, Cons. Engrs. Refers to E. B. Black, J. F. Brown, E. H. Dunmire, W. G. Fowler, F. A. Russell, C. S. Timanus, N. T. Veatch, Jr.

PEPE, SALVATORE ERNEST, Boston, Mass. (Age 26.) Jun. Engr., U. S. Engr. Office. Refers to J. E. Allen, F. P. Fifer.

REED, EDWIN WILLIAM, Woodhaven, N.Y. (Age 21.) Refers to W. Allan, R. E. Goodwin.

RICE, BORDEN PRATHER, Columbia, S.C. (Age 46.) San. Engr., South Carolina State Board of Health. Refers to H. Beebe, D. T. Duncan, A. Epstein, P. G. Hasell, A. E. Johnson, W. G. Jones, T. K. Legare, F. H. Murray, L. W. Pollard, R. L. Sumwalt.

ROCK, ELMER, Edgewood, R.I. (Age 26.) Hydr. Computer, U. S. Engrs., Providence, R.I. Refers to G. E. Barnes, M. S. Douglas, G. B. Earnest, F. L. Plummer, W. B. Rice.

ROSE, JESSE EUGENE, McKenzie, Tenn. (Age 38.) Jun. Engr., Tennessee State Highway Dept. Refers to E. W. Bauman, C. W. Butts, J. E. Moreland, J. L. Neely, Jr., F. S. Parrigin.

SANFORD, GEORGE OTIS, Arlington, Va. (Age 65.) Gen. Supervisor of Operation and Maintenance, U. S. Bureau of Reclamation, Washington, D.C. Refers to C. A. Betts, S. O. Harper, J. C. Page, C. H. Paul, R. F. Walter, F. E. Weymouth, F. E. Winsor.

SCHWARTZ, MOE ISAAC, Brooklyn, N.Y. (Age 24.) Refers to W. Allan, R. E. Goodwin, T. H. Prentice.

SHAW, GEORGE REED, Troy, N.Y. (Age 30.) Instructor, Dept. of Surveying and Road Eng., Rensselaer Polytechnic Inst. Refers to E. R. Cary, H. O. Sharp.

SHEPHERD, GEORGE EDWARD, Memphis, Tenn. (Age 35.) Prin. Engr. Aide (acting as Sec. Engr.), U. S. Engr. Office. Refers to V. M. Cone, H. B. Hooper, J. R. Newman, H. V. Pittman, B. A. Ross.

STONER, HARRY LEROY, Sacramento, Calif. (Age 49.) Associate Engr., U. S. Bureau of Reclamation, Central Valley Project, Sacramento Office. Refers to A. T. Larned, T. B. Parker, L. M. Pharis, A. B. Purton, J. L. Savage, H. H. Steinhauser, W. R. Young.

THOMPSON, WALTER EDWIN, Brooklyn, N.Y. (Age 36.) Refers to E. M. Browder, Jr., D. W. Krellwitz, P. W. Mack, E. Praeger, C. J. Renner, W. L. Selmer, D. B. Steinman.

TSCHEBOTAREFF, GREGORY PORPHYRIEWITCH, Princeton, N.J. (Age 38.) William Pierson Field Lecturer in Civ. Eng., Princeton Univ. Refers to G. E. Beggs, F. H. Constant, C. A. Hogentogler, E. A. Prentis, C. Terzaghi, E. K. Timby, L. White.

VOSTEEN, FRED HENRY, Beaumont, Calif. (Age 36.) Jun. Engr., Metropolitan Water Dist. of Southern California, Banning, Calif. Refers to G. E. Baker, J. B. Bond, J. L. Burkholder, R. B. Diemer, B. A. Eddy, H. A. Noble, N. D. Smith, J. J. Sorenson, R. Stephens, Jr.

WAIT, JOHN RUSSELL, JR., Houston, Tex. (Age 27.) With Eng. Dept., United Gas System. Refers to J. S. Broyles, H. E. Elrod.

WALKER, JOHN BEN, Washington, D.C. (Age 35.) Executive Secy. and Senior Engr., Board of Engrs. for Rivers and Harbors, U. S. Engr. Office, War Dept. Refers to W. J. Barden, N. W. Bowden, H. J. Casey, E. L. Daley, E. J. Dent, H. R. Faison, M. C. Tyler, B. R. Wood.

WALKER, WILLIAM SEFTON, Kinzua, Pa. (Age 30.) Party Chf., U. S. Engrs. Refers to F. J. Evans, G. M. Lehman, F. M. McCullough, P. A. Perrin, C. B. Stanton, H. A. Thomas.

WARDWELL, FRANK CARLTON, Chattanooga, Tenn. (Age 49.) Asst. Cost Engr. and Estimator, Office of Gen. Cost Engr., TVA, Knoxville, Tenn. Refers to J. G. Allen, L. V. Branch, J. B. Hays, R. F. Olds, T. B. Parker, H. T. Pierce, L. G. Warren.

WILNER, JACOB, Ann Arbor, Mich. (Age 38.) On valuation work, etc., with Jensen, Bowen & Farrell, Engrs. Refers to F. M. Bowen, K. A. Farrell, M. L. Harris, H. K. Hood, O. A. R. V. Jensen, W. Lahde, D. G. Mickle, H. E. Riggs.

WOO, HARRY BO-WING, Brooklyn, N.Y. (Age 26.) Refers to L. J. Addicott, E. H. Gaylord, Jr.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BAUER, EDWARD EZRA, Assoc. M., Urbana, Ill. (Elected Jan. 19, 1925.) (Age 40.) Asst. Prof. of Civ. Eng., Univ. of Illinois. Refers to M. L. Enger, R. P. Hoelscher, W. C. Huntington, H. H. Jordan, G. W. Pickels, J. Vawter, C. C. Wiley.

BAUMAN, EDWARD WALTER, Assoc. M., Nashville, Tenn. (Elected Nov. 10, 1930.) (Age 38.) Engr. of Materials and Tests, Tennessee Highway Dept. Refers to P. J. Freeman, A. T. Goldbeck, A. H. Hinkle, F. J. Lewis, F. V. Ragsdale, S. A. Weakley, W. H. Wilson.

BURCHARD, EDWIN DAY, Assoc. M., Asheville, N.C. (Elected July 6, 1925.) Dist. Engr., U. S. Geological Survey, Water Resources Branch. Refers to H. G. Baity, A. S. Fry, N. C. Grover, J. C. Hoyt, T. S. Johnson, C. G. Paulsen, W. M. Piatt, T. Saville, C. E. Waddell.

EVANS, JOHN MARSHALL, Assoc. M., San Francisco, Calif. (Elected Junior June 6, 1921; Assoc. M. Oct. 21, 1924.) (Age 44.) Head, Civ. Eng. Div., Standard Oil Co. of California. Refers to C. Derleth, Jr., W. Dreyer, B. A. Etcheverry, H. H. Hall, H. B. Hammill, W. H. Kirkbride, R. A. Monroe, I. C. Steele.

FISHER, LINDEN VAN HORN, Assoc. M., Bethlehem, Pa. (Elected Junior Oct. 10, 1921; Assoc. M. Aug. 30, 1926.) (Age 41.) Estimator and Designer, Bethlehem Steel Co. Refers to E. F. Ball, S. W. Bradshaw, J. Farenwald, J. Jones, C. H. Mercer.

GULICK, HAROLD VAN DYKE, Assoc. M., Schenectady, N.Y. (Elected Oct. 26, 1931.) (Age 39.) Constr. Engr., American Locomotive Co. Refers to C. N. Bainbridge, N. S. Buck-

bee, G. F. Burch, C. M. Everett, F. Gannett, C. T. Nitteberg, T. E. Seelye, W. C. Taylor, W. S. Todd, F. H. Weed.

HOLMES, PAUL MORDAUNT, Assoc. M., Columbus, Ohio. (Elected Nov. 12, 1928.) (Age 38.) Designing Engr., Div. of Eng. and Constr., City of Columbus. Refers to R. A. Allton, O. Bonney, F. W. Jennings, C. T. Morris, J. R. Shank, C. E. Sherman, F. D. Stewart.

KUCHAR, JOSEPH JAROMIR, Assoc. M., Montvale, N.J. (Elected Junior June 15, 1919; Assoc. M. Nov. 15, 1926.) (Age 42.) Secy., Treas. & Mgr., Kuchar Bros., Contrs. Refers to A. N. Aeryns, C. L. Bogert, S. M. Ellsworth, F. J. Keis, F. Kurtz, A. Potter, J. F. Sanborn.

LALONDE, WILLIAM SALEM, JR., Assoc. M., West Orange, N.J. (Elected Junior Oct. 12, 1925; Assoc. M. Aug. 26, 1929.) (Age 36.) Associate Prof. of Civ. Eng., Newark Coll. of Eng. Refers to J. B. Babcock, 3d, H. L. Bowman, H. N. Cummings, C. Gilman, A. G. Hayden, A. P. Richmond, Jr., R. Ridgway.

LEAHY, JOHN, Assoc. M., Mt. Vernon, N.Y. (Elected Assoc. M. Jan. 14, 1924.) (Age 49.) Supervisor, Linde Air Products Co., Prest O Lite Co., Carbide & Carbon Chemicals Corporation, New York City. Refers to C. D. Collins, S. R. Donnellon, E. B. Moss, H. L. Noyes, H. M. Priest, R. N. Shepard, J. Wilmot.

MANNING, JOHN JOSEPH, Assoc. M., Philadelphia, Pa. (Elected Aug. 28, 1922.) (Age 42.) Commander, Civ. Engr. Corps, U. S. Navy; Public Works Officer, 4th Naval Dist. and Navy Yard. Refers to W. H. Allen, R. E. Bakenhus, E. R. Gayler, A. L. Parsons, N. M. Smith.

MUESER, WILLIAM HENRY, Assoc. M., New York City. (Elected March 11, 1929.) (Age 37.) Member of firm, Moran, Proctor & Freeman. Refers to J. B. Babcock, 3d, H. L. Bowman, G. L. Freeman, H. M. Hale, E. H. Harder, D. E. Moran, W. Mueser, C. S. Proctor, C. H. Sutherland.

PREECE, EDMUND FRANCIS, Assoc. M., Washington, D.C. (Elected Feb. 23, 1932.) (Age 42.) Asst. Chf. Engr., ECW, National Park Service. Refers to M. Bernard, L. M. Gray, C. S. Jarvis, C. Jenkins, T. Saville, G. A. Sherron, O. G. Taylor.

UHR, SAUL, Assoc. M., Philadelphia, Pa. (Elected Junior Dec. 4, 1922; Assoc. M. Aug. 27, 1928.) (Age 39.) Res. Engr.-Inspector, PWA. Refers to H. C. Berry, W. H. Gravell, E. W. Renz, W. R. Sauter, E. L. Shoemaker, S. H. Widdicombe.

FROM THE GRADE OF JUNIOR

CROOM, WILLIAM PURYEAR, JR., Jun., Danville, Va. (Elected Nov. 11, 1929.) (Age 32.) Asst. City Engr. and Asst. Director of Public Works. Refers to G. McA. Bowers, W. R. Glidden, F. Jones, R. L. Maynard, H. E. Miller, R. S. Royer.

DALRYMPLE, TATE, Jun., Austin, Tex. (Elected July 25, 1932.) (Age 32.) Jun. Engr., Water Resources Branch, U. S. Geological Survey. Refers to E. C. H. Bantel, C. S. Clark, A. H. Dunlap, C. E. Ellsworth, J. A. Norris, T. Twichell.

JOHNSON, JOHN ALBERT, Jun., Denison, Tex. (Elected Jan. 25, 1932.) (Age 30.) Jun. Engr., acting as Asst. Chf. of Surveys, U. S. Engr. Office, Vicksburg, Dist. Refers to T. S. Burns, A. E. Clark, R. E. Goodwin, M. Henry, J. A. Rooney, W. W. Studdert.

KILEY, GEORGE THOMAS, Jun., Jersey City, N.J. (Elected June 4, 1928.) (Age 32.) With P. T. Cox Contr. Co., New York City. Refers to F. E. Cudworth, J. G. English, R. S. Moore, T. B. Rights, R. T. Robinson, S. Rosenberg.

LESLIE, JAMES BOOTH, Jun., Vicksburg, Miss. (Elected July 5, 1933.) (Age 31.) Asst. Engr., U. S. Engr. Dist. Refers to C. A. Baughman, O. G. Baxter, S. J. Buchanan, J. A. C. Callan, G. R. Clemens, H. H. Houk, G. H. Matthes.

MCCARTY, JOHN WESLEY, Jun., Arcola, Ill. (Elected Nov. 10, 1930.) (Age 27.) Jun. Engr., Illinois Dept. of Public Works & Bldgs., Div. of Highways. Refers to C. H. Apple, R. S. Crossman, W. C. Huntington, H. H. Jordan, N. D. Morgan, C. E. Palmer.

MCQUEEN, JAMES MILTON, JR., Jun., Washington, D.C. (Elected Oct. 24, 1932.) (Age 28.) Asst. Civ. Engr., U. S. R A, Inspection Div. Refers to N. F. Fenn, O. B. French, J. E. Lapham, P. O. Macqueen, A. B. McDaniel, H. L. Newhall.

MILLER, HERBERT WILFRED, Jun., San Francisco, Calif. (Elected Oct. 29, 1934.) (Age 32.) Asst. Highway Engr., Div. IV., Div. of Highways. Refers to S. S. Gorman, J. W. Green, N. A. Grover, N. C. Raab, L. J. Stephenson.

MUNROE, JAMES EDWARD, Jun., North Attleboro Mass. (Elected May 25, 1931.) (Age 31.) Engr. and Gen. Supt., James A. Munroe & Sons, Gen. Contrs. Refers to L. T. Bohl, A. L. Shaw, B. F. Snow, J. P. Wentworth, P. E. Winsor.

PATTERSON, ROBERT SHEPHERD, Jun., Kansas City, Mo. (Elected Oct. 26, 1931.) (Age 32.) Designer with Black & Veatch. Refers to E. B. Black, W. G. Fowler, G. A. Hathaway, F. A. Russell, W. M. Spann, C. S. Timanus, N. T. Veatch, Jr.

POULTER, ALFRED FEAREY, Jun., Menlo Park, Calif. (Elected May 13, 1929.) (Age 32.) Mgr., California Water Service Co. Refers to T. C. Binkley, H. J. Brunnier, H. A. Harris, Jr., C. G. Hyde, E. F. Levy, W. Stava, J. A. Wade.

SHADRAKE, BOLICK JOHN, Jun., Cleveland, Ohio. (Elected Nov. 14, 1927.) (Age 32.) Draftsman, Office of Engr. of Structures, Erie R. R. Co. Refers to H. K Barrows, C. J. Eldridge, J. Greer, H. M. Shepard, J. W. Smith, C. H. Splitstone, C. M. Spofford.

TROY, ANTHONY VINCENT, Jun., Yonkers, N.Y. (Elected Oct. 1, 1928.) (Age 32.) Asst. Engr., PWA, in charge of Document Sec., New York State Inspection Div., New York City. Refers to M. E. Gilmore, S. G. Hess, P. A. Kelly, G. S. Rinehart, H. B. Wheatcroft, Jr.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1936 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

ENGINEER; M. Am. Soc. C.E.; 10 years experience in charge of construction and design of tunnels, shafts, subways, dams, power houses, and heavy foundations; seeks connection with responsible firm. Has record of most successful projects and new methods of construction of minor costs. Highly endorsed. Reported in textbooks. Reasonable salary accepted. Eastern states. C-9867.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; B.S.C.E., New York University, 1932; 1½ years with general contractor as draftsman, surveyor, assistant supervisor; 3 years with New York City Department of Parks as rodman, transitman, and chief of party on topographical and hydrographical surveys; construction surveys, giving line and grade for construction roads, buildings, wading pools, swimming pools, etc. Available on short notice. D-5802.

CONSTRUCTION, EXECUTIVE; Assoc. M. Am. Soc. C.E.; long, varied experience on design and construction of irrigation and flood-control projects; construction and operation of water supply; public utilities manager. Available immediately. A-3938.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 30; graduate; New York state license; 7 years with general contractors on tunnel construction, compressed air work as field engineer, hydrographic construction, dredging, soundings, surveys, building construction, design, estimating, inspection. Employed on construction in Washington, D.C. Available in March. Location, East. D-1921.

CIVIL ENGINEER; M. Am. Soc. C.E.; technical graduate; married; 10 years diversified experience, drainage surveys, railroad construction and design of structures, mass transportation studies, and extensive valuation; 20 years in executive capacity, directing engineering department and construction forces for a large railway rehabilitation and maintenance program. Anywhere in United States. Available immediately. A-1864.

EXECUTIVE

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 48; married; licensed New York state; 15 years general building experience—8 as chief engineer, city department public buildings; 4 years ferry docks, piers, waterfront construction; 3 years residential building, development; 2 years teaching Princeton University. Desires permanent connection. Speaks English, French, and Spanish. Would consider traveling. B-3677.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate engineer; 20 years experience on large steel and reinforced concrete structures, deep foundations, hydraulics, stress analysis, estimates, reports, and construction. Wishes permanent position. Location optional. B-4836.

CONSULTANT, CHIEF ENGINEER, CITY MANAGER; M. Am. Soc. C.E.; age 58; married; graduate; 33 years experience; Indiana and Michigan registration; 25 years consulting engineer (bridges, buildings, harbor development, public works); 2½ years with PWA; effective speaker and writer on public and technical affairs; now in charge large sewage treatment project (for PWA). D-5814.

EXECUTIVE, CHIEF ENGINEER, CONSTRUCTION MANAGER; M. Am. Soc. C.E.; 30 years comprehensive experience, construction, maintenance, and operation, including industrial plants, water supply and canals, steam and hydroelectric power. Estimates, plans, specifications, supervision of construction, and initial operation. B-3914.

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